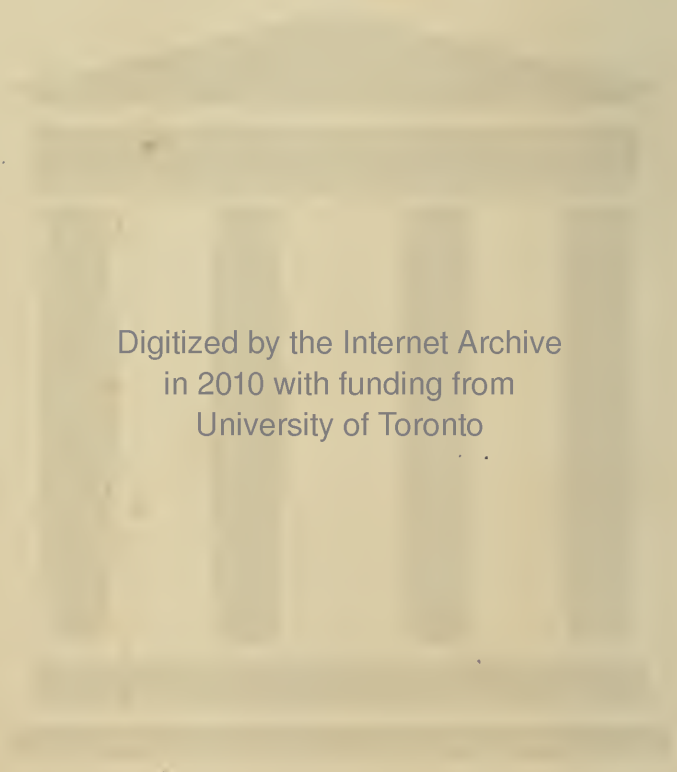






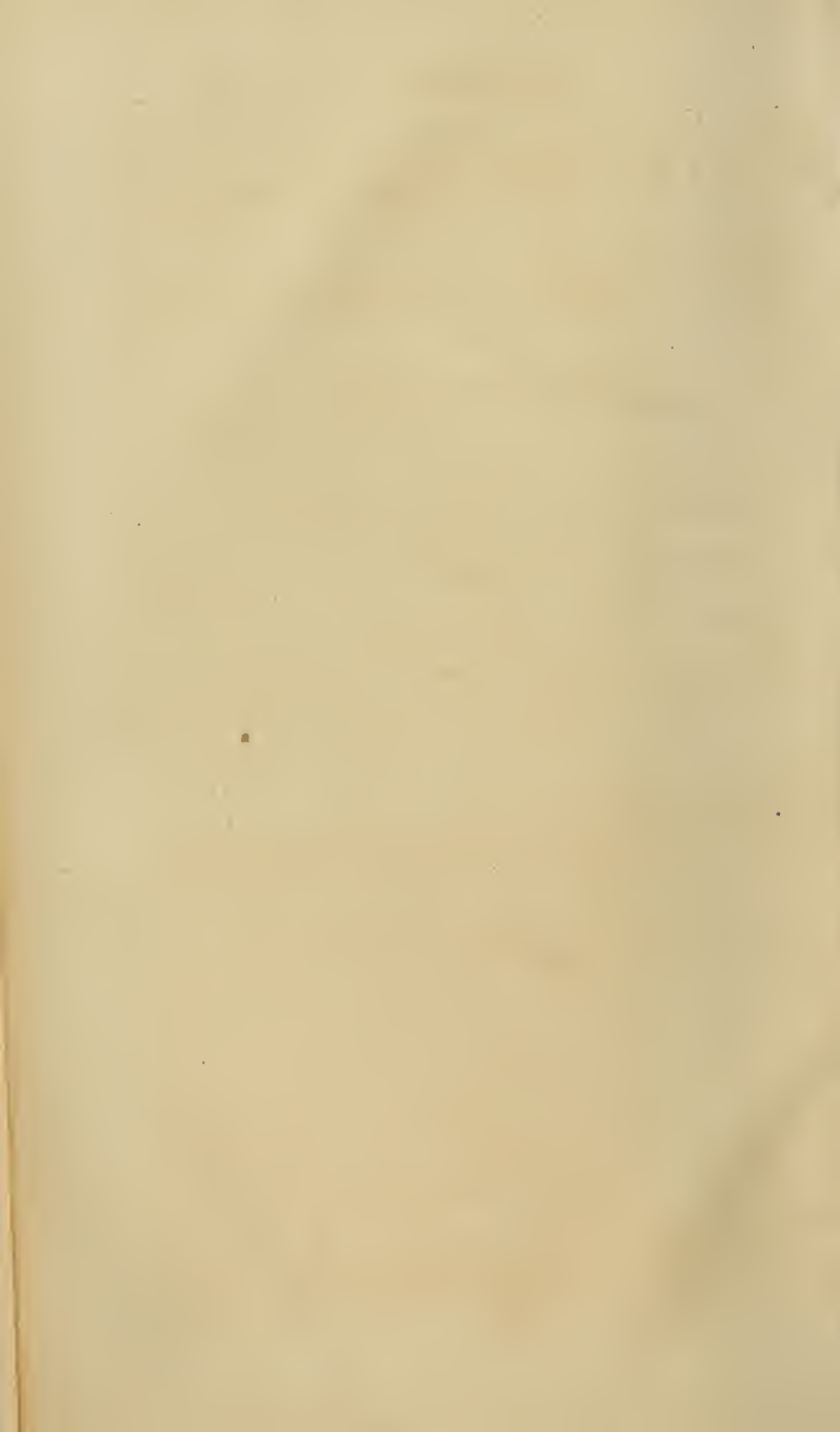




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**JOURNAL**

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OF THE

**FRANKLIN INSTITUTE**

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OF THE

**State of Pennsylvania**

AND

**MECHANICS' REGISTER.**

DEVOTED TO

MECHANICAL AND PHYSICAL SCIENCE,

**CIVIL ENGINEERING, THE ARTS AND MANUFACTURES,**

AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

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EDITED

BY THOMAS P. JONES, M. D.

MEMBER OF THE AMERICAN PHILOSOPHICAL SOCIETY, OF THE ACADEMY OF NATURAL SCIENCES, PHILADELPHIA, THE AMERICAN ACADEMY OF ARTS AND SCIENCES, MASSACHUSETTS, THE NATIONAL INSTITUTION FOR THE PROMOTION OF SCIENCE, WASHINGTON, CORRESPONDING MEMBER OF THE POLYTECHNIC SOCIETY OF PARIS, AND OF THE CHILIAN AGRICULTURAL SOCIETY, SANTIAGO.

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JANUARY, 1840.

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**Practical and Theoretical Mechanics and Chemistry.**

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*Reply to the Remarks of Dr. Hare, on the Essay of Wm. Gries, M. D., relating to the supply of rooms with heated air.*

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

SIR,—I owe it to myself, and to the cause of science, that I should reply to Professor Hare's remarks, published in the October number of your Journal, on my essay, published in the August No. of the same Journal. The reason that I have not attended to this sooner is, that I was absent from my home for two months, and did not see his paper till the last week in December.

When I prepared my essay I wished to occupy as little space in your valuable Journal as possible. The principle appeared to my mind so very plain and simple, that I expected the merely indicating it, to men of science, would be sufficient: but I must have been exceedingly obscure in my language, when such a scientific mind, as the learned professor's, has entirely mistaken my views.

When I first saw his communication, my idea was to leave it, without further comment, to the scientific public, to compare our papers, and to decide upon them; but the public is so much governed by the authority of great names (not having sufficient leisure to examine for themselves)—and the professor's being so deservedly established, by his many claims to priority of discovery, that I fear my humble essay would be entirely overlooked; for I have no other ground than the soundness of my position, and the strength of my arguments to sustain it.

The opinion generally entertained, with regard to introducing heated air into apartments, was that it is immaterial in what direction we bring it in, so that it is near the floor—that it would then diffuse itself as well with one mode of introduction as another, and this opinion I attempted to combat in

my essay. Dr. Hare, no doubt unintentionally, entirely misstates my views, when he says that I "think it expedient to have it enter near or through the floor." This represents me as writing nonsense—for do I not speak distinctly against letting it pass through a hole or grate in the floor? and surely this would be "near or through the floor." The principle that I want to establish is, that the flues or pipes by which the heated air passes off from the heat-chamber, into the apartment to be warmed, in whatever direction they be carried under and through the floor, should not terminate there, but pass above the floor, and there have a horizontal direction, (or parallel with the floor) to some extent, before they terminate. What specific length this horizontal branch should have, it would require many experiments to establish. My horizontal branches were six inches long, as stated in my essay. When I spoke of giving this horizontal direction to the hot air, whilst it was yet in a constrained passage, I thought that if my language was not sufficiently explicit, that the apparatus which I applied and described, would make it plain enough—at any rate, it was intended to convey what I have now in other words described above. The momentum or force which I contend the heated air has, when it issues from the heat-chamber—and which I say so powerfully contributes to carry it to the ceiling, when it passes through a mere opening or openings in the floor, I see Dr. Hare destroys by his arrangement of many small perforations; for, if I understand his language, all his openings, distributed over a surface of thirty feet, are mere openings in the floor, covered with perforated plates, and do not change the vertical current of heated air. Now, for this arrangement of Dr. Hare's I cheerfully concede to him all the credit it deserves, and grant too that he adopted it *not by accident, but upon reflection, and upon principles that he perfectly understands*. But I beg leave to assure him, that if he thinks that these views are parallel with mine, *that he has neither by accident nor reflection fallen on my views*. The momentum or force I speak of is a very desirable agent with me—I do not wish to destroy it,—but to apply it to a very useful purpose, and on this I build my claims of discovery. By bringing the heated air into the horizontal branch or branches of flues, this force is expended in carrying the heated air over the apartment, and into every part of it; that it does this, I have sufficiently established. The column of hot air, as it passes from the flue, meeting with the resistance of the atmosphere, produces a spray, analogous to the spray of water from the branch pipe of a fire engine, and is in this way divided into many parts, and commingles thus with the cold air—every small division passing in the desired direction, until the momentum is expended. And as a part of the spray from a fire engine, when the column of water first divides (the branch pipe being held horizontally) passes upwards contrary to its own gravity, so a part of the spray of heated air passes downwards; as may be readily seen in my arrangement. The horizontal pipes are six inches from the floor, and yet small light articles are blown along the floor to its very extremity. Although my horizontal pipes are six inches above the floor, I feel convinced that it is best to have them much nearer, as I stated in my former essay. To cover my horizontal branches or flues with plates, replete with many perforations, would be as unwise as to cover with a similar plate the branch pipe of a fire-engine.

Respectfully,

WM. GRIES, M. D.

*Womelsdorf, Pa., Dec. 30th, 1839.*



*History of the Steam Engine, with a reply to the Criticisms to which the first publication of the article gave rise.\**

BY M. ARAGO.

[FROM the Annual of the Board of Longitude, for 1836.]

TRANSLATED BY LIEUT. A. A. HARWOOD, U. S. N.

The steam engine has already rendered such important services to navigation and the arts, that we cannot be surprised at the eagerness with which researches have been made to ascertain the share which different nations may claim in this admirable invention.

The fact will nevertheless excite some surprise, that in England alone, the booksellers have sold, in a very few years, more than an hundred thousand copies of numerous works, in which this historical question is argued. This brilliant success is, I doubt not, principally due to the lively interest which the steam engine must naturally excite in a country in which it is every where in use; but perhaps, we shall not be far wrong in attributing some portion of it to national pride. Ask, in fact, the members of the House of Lords, and the simple artisan, the city merchant whose brilliant speculations have conducted him to every region of the globe, and the farmer who has never been beyond the limits of his native country; visit the immense manufactories of Birmingham, Manchester, and Glasgow, and the humblest workshop;—everywhere you will be told that the Marquis of Worcester was the first inventor of the steam engine; and after his name, you will find in every body's mouth the names, *all English ones*, of Savery, Newcomen, Beighton, Watt, Hornblower, Woolf, &c. In general, literary persons, and those especially devoted to the cultivation of science, are not more liberal in their opinions upon this subject. In Dr. Rees' Cyclopædia, we find these remarks: 'The Steam Engine follows next to the Ship in the scale of inventions; but in an English Cyclopædia it will take the lead, from the circumstance of its being wholly invented and brought into general use by our countrymen, (article Steam Engine, 2d col.) and eleven lines lower down, as if the first passage was not sufficiently explicit,—'The Steam Engine is the invention of a few individuals, all of them Englishmen.' The celebrated professor John Robison, of Edinburgh, is equally positive. 'The Steam Engine,' says he, 'was beyond all doubt first invented by the Marquis of Worcester, in the reign of Charles the Second.' (See a *System of Mechanical Philosophy*, vol. II, p. 46.) After having afterwards refuted, by arguments which I shall examine, the pretensions of French authors, who affect to blend the name of Papin with the history of the Steam engine, Robison declares, that he does not hesitate at all to give the honour of the first and complete invention to the Marquis of Worcester. (See a *System*, &c., page 50.) A *Savant* not less illustrious for depth of knowledge than for vast erudition, Dr. Thomas Young, has added his imposing testimony to those already cited. According to him, the Marquis of Worcester is the first inventor of the Steam Engine, and the first who made use of the pressure of steam as a moving power. In the rapid sketch which he gives of the

\*No apology is necessary for presenting to our readers an article of permanent interest, like this, which has been twice published in the *Annuaire* of the Board of Longitude. We hope that some of our Correspondents may be induced, by seeing the article in English, to set the claims of our countrymen, Rumsey, Fitch, Evans, Stevens, and Fulton, in a more just light than is here done.



improvements which this machine has successively received, English machinists alone are made to figure, (*Lectures on Natural Philosophy*, vol. 1st, p. 346 a 356,) I might also cite Mr. Millington, the able professor of Mechanics at the Royal Institution, Mr. Lardner, a distinguished member of the New University of London, and Mr. Nicholson, the author of a valuable treatise on practical Mechanics.

Decisions so numerous, so positive, and derived from works of such high reputation did not seem to me, at first, to admit of the shadow of a doubt. When, therefore, at the request of the pupils of the Polytechnic School, I attempted, some years ago, to trace the chronological series of improvements which the steam engine has undergone, from its origin up to the present day, I frankly acknowledge I expected to have none but English mechanicians to quote. This however was an error : our neighbours of the other side of the channel are neither the only nor even the first inventors of the Steam Engine. This at least appears to me to be proved by the passages which I now submit to the readers of the *Annuaire*. I feel sure, at all events, of having examined this curious point in the history of the sciences without prejudice, and that my citations and analyses may be depended upon as exact. If the deductions from them are not so, the reader will be able to rectify them himself, since he will be furnished with all the elements of the question.

I ought, before concluding this preamble, to observe further that there has recently appeared in England a remarkable work, entitled *a descriptive History of the Steam Engine*, by Mr. Robert Stuart, in which all the attempts which have been made to use steam as a mechanical agent are estimated with a great deal of discernment; and, which is still rarer, with an entire disregard to national prejudice. With few exceptions, the opinions of Mr. Stuart upon the relative merits of the engineers who have contributed to the creation of this wonderful machine, agree perfectly with those which I had formed from the study of the original records. I naturally take advantage of this flattering coincidence with eagerness; I may even add that if my memoir had not been nearly drawn up when Mr. Stuart's history came into my hands, I should probably have been satisfied with the insertion of a simple analysis of his book, by doing which, the end that I proposed to myself would have been equally attained.

I hope the reader will appreciate the motives which have determined me not to follow strictly a chronological order in every part of this article. I have concluded that there would be greater clearness in collecting together the paragraphs relating to the various and more or less advantageous modes which have been successively conceived for the employment of steam.

The details of mechanism, though very important, seem to me to be of secondary consideration.

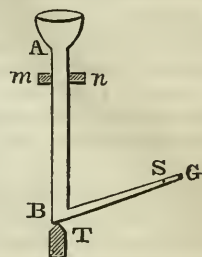
#### 120 years B. C. *Hiero of Alexandria*.\*

When liquids, gases, or vapours, flow from vessels which contain them un-

\*Hiero of Alexandria, lived nearly 120 years before our era. The greater part of the numerous works which he composed are lost; there are only three of them remaining. The reacting machine here in question, is found described, and represented in the treatise, entitled, *Spiritualia seu pneumatica*. The invention of cog-wheels is claimed for Hiero; but this honor belongs, I believe, to his master Ctesibius. His water clocks, and above all, his automata, excited the admiration of antiquity. The fountain which bears the name of Hiero has been applied to various important purposes, even in our days; it serves for instance, in the mines of Schemnitz, in Hungary, as a draining machine.

der certain conditions which I shall describe, they become a cause of motion which it is necessary to estimate properly in order to understand the operation of a little apparatus contrived by Hiero of Alexandria, which offers, I think, the first example of the employment of steam as a motive force.

Imagine a bent tube A, B, G, the two branches of which A, B, and B, G, meet each other rectangularly. Let us suppose that the branch B, A, is vertical, that it passes freely through a fixed ring *m*, *n*, and that it rests beneath upon a sharp point T, so as to turn upon itself without interruption. If in this situation water is poured in by the upper funnel, we shall have two distinct cases to consider. When the liquid flows through the extremity G, in the direction B, G, the whole apparatus will remain motionless. When, on the contrary, the tube B, G, is stopped at its extremity G, and the liquid escapes only by the lateral opening S, in a horizontal direction, the machine will be put in motion. It will turn round A, B, as long as the flow continues, but in a contrary direction to that in which the jet is formed. If, for instance, the water is forced forward, the horizontal tube B, G, will revolve in a contrary direction by a species of recoil.

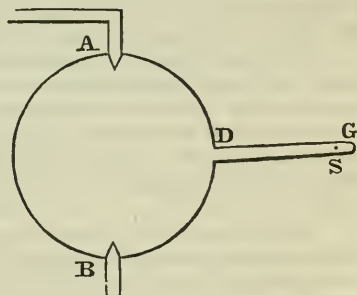


All the machines in which water has been thus employed, are called *reacting machines*.

A gas passing rapidly through the bent tube A, B, G, would produce the same effects as the water: the tube would be at rest while the gas escaped in the direction B, G; on the contrary, it would turn if the escape took place laterally.

These preliminary considerations will suffice to explain the mode of action of steam in the machine of Hiero.

Let us imagine that a hollow metallic sphere, contrived so as to turn between two pivots A, and B, is filled with a very elastic vapour; that this vapour may escape from the sphere by a projecting tube D, G, perpendicular to A, B, and placed upon the prolongation of one of the radii. We have already seen that if the tube D, G, is open at its extremity, it will not incline to revolve, and that the sphere will remain at rest; and on the contrary, that if the escape takes place by



the lateral opening S, in front for instance, the tube will recoil, and will tend to make the sphere to which it is attached revolve with a backward motion. To ensure the continuance of this rotary motion it will suffice to add to the preceding suppositions, that one of the two pivots, (A for instance) is hollow, that it communicates at one end with the inside of the sphere, and at the other with the boiler: the steam expended at S, will in this way be constantly replaced as fast as it escapes.

In the figure which Hiero has given of his little apparatus, two tubes are seen like that which I have just described. They form the opposite prolongations of the same diameter, and their lateral openings are so disposed as to make the sphere turn in the same direction.

There is also in the *Spiritualia* the description of a machine differing from the preceding in this particular only, that a current of heated air takes the place of a current of vapour.

To sum up, we find a certain employment of aqueous vapour in one of the contrivances described by Hiero; but the action of this vapour differs from that of steam in modern machines. Watt, to whom the experiments of the Greek mechanician were not unknown, thought that no use could be made of them. Others, if I am correctly informed, have entertained, on the contrary, a sufficiently favorable opinion of the effects which might be produced by Hiero's mechanism, when perfected, to have sought to secure to themselves the exclusive enjoyment of them by a patent. Time and experience will decide. We see only, that if by modifications of which we now have no idea, steam machines upon a reacting principle shall one day or other succeed, and it is thought necessary to write a history of them, the honour of their first invention must be awarded to Hiero. For my part I might have passed them over altogether in silence, since I have only to do with known machines, such as are in common use, and which have no affinity with the revolving sphere of the Alexandrian philosopher. Perhaps, indeed, it had been proper to cite here in preference, authors, who, like Aristotle, and Seneca, attribute earthquakes to the sudden transformation of water into steam. This change, according to them, takes place in the womb of the earth by subterranean heat, and the prodigious effects which they endeavor to account for, shew clearly the enormous mechanical power they imputed to steam. I hope, at all events, that this article may find excuse when it is seen that it gives a natural solution of the important question to which the paper which I am now going to take up has given rise.

1543. *Blasco de Garay.*

M. de Navarrete, published in 1826, in the Baron de Zach's Astronomical Correspondence, the following note, which was communicated to him by Mr. Thomas Gonzalez, director of the royal archives of Simuncas.

"Blasco de Garay, a Captain in the Navy, proposed in 1543, to the Emperor and King Charles the Fifth, a machine to propel large boats and ships even in calm weather, without oars or sails.

"In spite of the impediments and the opposition which this project met with, the Emperor ordered a trial to be made of it in the port of Barcelona, which in fact took place on the 17th of the month of June, of the said year, 1543.

"Garay would not explain the particulars of his discovery; it was evident, however, during the experiment, that it consisted in a large copper of boiling water, and in moving wheels attached to either side of the ship.

"The experiment was tried on a ship of 200 tons, called the *Trinity*, which came from Colibre, to discharge a cargo of corn at Barcelona, of which Peter de Scarza was Captain.

"By order of Charles V, Don Henry de Toledo, the Governor, Don Pedro de Cordova, the Treasurer, Ravago, and the Vice Chancellor, and Intendant of Catalonia, witnessed the experiment.

"In the reports made to the Emperor, and to the Prince, this ingenious invention was generally approved, particularly on account of the promptness and facility with which the ship was made to go about.

"The Treasurer, Ravago, an enemy to the project, said that the vessel could be propelled two leagues in three hours; that the machine was too complicated and expensive, and that there would be an exposure to danger



in case the boiler should burst. The other Commissioners affirmed, that the vessel tacked with the same rapidity as a galley manœuvred in the ordinary way, and went at least a league an hour.

"As soon as the experiment was made, Garay took the whole machine with which he had furnished the vessel, leaving only the wooden part in the arsenal at Barcelona, and keeping all the rest for himself.

"In spite of Ravago's opposition and contradiction, Garay's invention was approved, and if the expedition in which Charles V, was then engaged had not prevented, he would no doubt have encouraged it.

"Nevertheless, the Emperor promoted the inventor one grade, made him a present of 200,000 maravedis, ordered the expense to be paid out of the Treasury, and granted him besides many other favours.

"This is derived from the documents and original registers kept in the Royal Archives of Simuncas, among the commercial papers of Catalonia, and from those of the military and naval departments for the said year, 1543.

"THOMAS GONZALEZ.

"*Simuncas, August 27, 1825.*"

According to M. Navarrete, it follows from the note which we have just read that, *the invention of steam vessels is Spanish, and has only been revived in our days.* From this, also, is deduced another consequence, viz: that Blasco de Garay ought to be regarded as the real inventor of the steam engine.

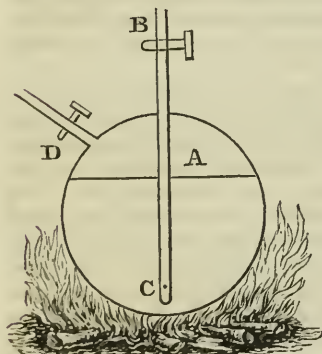
These pretensions seem to me to be from their nature inadmissible. As a general position the history of the sciences should be derived exclusively from printed papers. Manuscript documents cannot have any value with the public, because, generally, it has no means whatever of verifying the date assigned to them. Extracts from manuscripts are still less admissible. The author of a review does not, sometimes, perfectly understand the work which he attempts to analyse, and he substitutes, even without intending it, popular opinion, or his own, for the ideas of the writer which he abridges. I will concede, however, that neither of these difficulties is applicable to the present case; that the document quoted by M. de Navarrete is actually one of 1543, and that the extract of M. Gonzalez is authentic: but what then?—Why in 1543 an attempt was made to propel vessels by a certain mechanical means, nothing more. The machine, it is said, contained a boiler, and therefore it was a steam machine. This reasoning is not at all conclusive. There exists, in fact, in various works, plans of machines, in which fire is seen under a boiler filled with water, steam having no part in the matter; such, for instance, is the machine of Amontons. After all, even if we were to admit that the machine of Garay was set in motion by steam, it would not necessarily follow that the invention was new and that it bore any resemblance to those of our day, because Hiero, as we have already seen, described 1600 years before, the means of producing a rotary motion by the action of steam. I will even add that supposing the experiment of Garay to have taken place, and that his was really a steam machine, every thing would lead us to believe that he employed the eolipile of Hiero. This apparatus, in fact, could not be of very difficult construction, since we may boldly affirm, that the simplest of our modern steam machines would require a nicety of workmanship vastly beyond any thing which could have been obtained in the sixteenth century. Besides, Garay having refused to explain his machine to any one, even to the commissioners nominated by the Emperor, every attempt which may be made after the lapse of three

centuries to establish in what it consisted, will evidently lead to no certain result.

To recapitulate: the new document brought to light by M. de Navarrete ought to be set aside, in the first place, because it was not printed in 1543 nor since; secondly, because it does not prove that the impellant of the Barcelona ship was a real steam machine; thirdly, because if a steam machine by Garay ever did exist, it was, according to all appearance, the reacting eolipile already described in the works of Hiero, of Alexandria.

1615, *Solomon de Caus*.\*

Solomon de Caus is the author of a work entitled, *The reasons of moving powers, with diverse machines both useful and entertaining*.—(*Les Raisons des forces mouvantes, avec diverses machines tant utiles que plaisantes, etc.*) This work appeared at Frankfort in 1615. We there find, among other ingenious things, that many mechanicians have presented in our day as new, a theorem thus conceived, under No. 5. *Water by the aid of fire will ascend above its level*. Here are the terms in which de Caus justifies this assertion.



“The third means of making water rise is by the aid of fire, by which means various machines may be made. I will give here the demonstration of one of them.

“Let there be a copper ball marked A, well soldered all around, to which there shall be a vent, marked D, by which water may be introduced, and also a tube marked B, C, which shall be soldered at the top of the ball, and the end of which C, shall nearly reach the bottom without touching it; then the said ball must be filled with water through the vent and then be well closed and placed upon the fire; then the heat acting upon the said ball, will cause all the water to rise through the tube B, C.”

The apparatus, a description of which I have just transcribed, is a true

\* By a caprice, well worthy of remark, a man whom posterity will regard, perhaps as the first inventor of the steam engine, is only cited in Montucela's history of the mathematics on account of his treatise upon perspective, and then the citation consists of only five words. He has also barely obtained the honour of an article of a few lines in the voluminous biographical dictionaries of our own day. The universal biography gives him birth and a grave in Normandy. It says that he lived in England for some time, where he was attached to the household of the Prince of Wales. In *The reasons of moving forces*, Solomon de Caus takes himself the title of “*Engineer and Architect of his Highness the Elector Palatine*.” This work was composed, I believe, at Heidelberg; it was printed at Frankfort; these three circumstances have given rise to the idea that de Caus was a German. But let us remark, in the first place, how improbable it is that a German would have written in French in his own country. Add to this, that in his dedication to his most Christian Majesty (Louis XIII) the following formula precedes the signature: *de votre Majesté, le tres obéissant sujet*; that finally, we read in the license, and this cuts short all doubt: “Our well beloved Solomon de Caus, master engineer, *being at present* in the service of our dear and well beloved cousin, the Prince Elector Palatine, has caused us to be informed, etc. \* \* Wishing to gratify the said de Caus he being *our subject*, etc.” Thus we find that Solomon de Caus was a Frenchman.

steam draining machine. But perhaps it might be supposed, if I were to limit myself to the preceding passage, that Solomon de Caus was ignorant of the cause of the ascension of the fluid through the tube B,C. It was, however perfectly known to him, a proof of which may be found in his first theorem, p. 2 and 3, where, in a similar experiment, he says that "the violence of steam (produced by the action of fire) which causes the water to rise, proceeds from the said water, which steam will escape, after the water shall have gone out through the cock, with great violence."

1629. *Branca.*

Branca is the author of a compilation entitled: *Machines of Sig. G. Branca; Rome, 1629.* This work contains the description of all the machines with which the author had become acquainted. Among these we remark an eolipile placed on a brazier, and arranged in such a way that the current of steam rushing through a tube should strike the wings or the buckets of a small horizontal wheel and cause it to turn. The wind from the nozzle of an ordinary bellows would evidently have produced the same effect. I have not been able to comprehend the analogy by which persons have perceived in this eolipile the first germ of the steam engines of the present day. At all events, and I shall limit myself to the remark, that the compilation of Branca bears a much later date than the first two editions of the work of Solomon de Caus.

1663. *The Marquis of Worcester.\**

*The Scantling of one hundred inventions.* by the Marquis of Worcester, appeared in 1663, in the reign of Charles II. This book is more generally known by the title of the *Century of Inventions*. The apparatus which English authors regard as the *first steam engine* (*la première machine à feu*) is described in these terms, under the head of the 68th invention:—

"An admirable and most forcible way to drive up water by fire, not by drawing or sucking it upwards, for that must be, as the philosopher calleth it, *intra sphæram activitatis*, which is but at such a distance. But this way hath no bounder, if the vessel be strong enough; for I have taken a piece of a whole cannon, whereof the end was burst, and filled it three-quarters full of water, stopping and screwing up the broken end as also the touchhole; and making a constant fire under it, within twenty-four hours it burst, and made a great crack: so that having a way to make my vessels so that they are strengthened by the force within them†, and the one to fill after

\* Edward Somerset, Marquis of Worcester, whom the English regard as the true inventor of the steam engine, lived in the reign of the last of the Stuarts. Involved in all the intrigue of this epoch, he suffered many vicissitudes. Worcester lost, at first his immense fortune; went into Ireland; was there imprisoned; made his escape and reached France; returned to London by the orders of Charles II, was discovered and imprisoned in the Tower from which he was not released until the restoration. Tradition relates that the ideas concerning the uses in which it would be possible to employ the power of steam, were awakened during his last imprisonment by the sudden raising of the lid of the pot in which his food was cooked. The anecdote, if true, does honour to the inventive genius of the prisoner; but shews, at the same time, his want of erudition; because it must be admitted that he was not acquainted with the work of Solomon de Caus, a second edition of which had appeared in France while Worcester resided there.

† It has appeared to me that *force within them* cannot mean the means of interior consolidation. If I understand the expression, Worcester, in order to answer an ob-



the other. I have seen the water run like a constant fountain stream forty foot high; one vessel of water rarefied by fire driven up forty of cold water. And a man that tends the work is but to turn two cocks, that, one vessel of water being consumed, another begins to force and refill with cold water, and so successively, the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim, between the necessity of turning the said cocks."

The reader knows now all that the Marquis of Worcester has ever written upon the steam engine. It is the sole title upon which Mr. Partington, of the London Institution, in his new edition (1825) of the *Century of Inventions*, founds his decision and that of his countrymen, that "Worcester is the first discoverer of a means of applying steam as a mechanical agent; an invention which is alone, he adds, sufficient to immortalize the age in which this man lived." Let us, in our turn, examine this paragraph, so often cited, and see impartially what is to be found there.

I perceive in it, at first, an experiment which shows that water reduced to steam, can, in time, burst the sides of the vessel in which it is confined. This experiment was known in 1605, for Flurence Rivault says expressly that the eolipile bursts with a loud report when the steam is hindered from escaping. He adds even: *the effect of the rarefaction of water is enough to dismay the boldest men.*—(*Elémens d'artillerie*, p. 128, Paris, 1605.\*)

I perceive, secondly, the idea of raising water by the aid of the elastic force of steam. This idea belongs to Solomon de Caus, who had published it forty eight years before the English author.

Finally, I find in it the description of an apparatus proper for producing this effect; but which does not recognize that the metallic ball of Solomon de Caus would raise water also to any height, supposing its sides to be strong enough and the heat to be sufficiently intense. Perhaps it will be said that the machine of the Marquis of Worcester is the better of the two. I may grant all this without its being of any consequence since it is not now a question to discover who was the most ingenious in contriving steam en-

jection which he foresaw, found it convenient to assure us that his new boilers would never burst, and in fact he would have attained that object, if, as he said, they would become stronger in proportion to the intensity of pressure of the steam outward. This circumstance will give new weight to the opinion of those who think that Worcester never made trial of his machine; but I hasten to remark that all this is unimportant as far as the question of priority under discussion is concerned.

AUTHOR.

This hypercriticism loses its force entirely when the true meaning of Worcester's assertion is considered. He does not say that the vessels are strengthened by the force of the steam within them but by "the force," alluding, obviously, to the means employed for strengthening.

TRANS.

\* I borrow this quotation from one of the curious historical articles so rich in erudition, which M. Montgéry has published upon machines, in which fire is in any manner employed, and I have substituted it for the following passage of Solomon de Caus which I had at first inserted in the text. This passage appeared but ten years later; that is to say in 1615; nearly fifty years, however, before the *Century of Inventions*: "The violence will be great when the water evaporates in air by means of fire, and when the said air is enclosed; as, for instance, let there be a ball of copper of one or two feet in diameter, and an inch thick, which shall be filled with water through a little hole, which shall be well stopped by a nail, so that the water cannot escape from it; it is certain that if the said ball be placed on a large fire so that it becomes very hot, that it will cause a compression so violent that the ball will burst in pieces with a noise like that of a petard." (*Les Raisons des Forces mouvantes*, livre première, feuille première.)

gines, but simply who it was that first thought of making use of the elastic force of steam to raise a weight or to produce motion. Moreover, before comparing the plan of the Marquis of Worcester with others, it is necessary to know exactly in what the first consisted. This problem has not yet been solved, for the simple reason that the description of the sixty-eighth invention of the English peer is entirely deficient in perspicuity. Nobody in the present day, would find any difficulty in constructing a draining machine in which water would be raised by the action of steam; but when the question arises, to reproduce that of the Marquis of Worcester, we must limit ourselves to do what the author says, and no more.

In imposing upon himself these two conditions, Mr. Stuart decides that we shall approach, as near as possible, to the description of his countryman, by combining two of Solomon de Caus' machines in such a way as to produce, by their alternate action, a continual efflux. The other solutions which have been given, so far, of the same question, that of Millington, for instance, are evidently inadmissible.

When Messrs Thomas Young, Robison, Partington, Tredgold, Millington, Nicholson, Lardner, etc., brought forward the Marquis of Worcester as the inventor of the steam engine, the work of Solomon de Caus was, no doubt, unknown to them.

Since it is now established, beyond dispute, that the first idea of raising a weight by means of the elastic power of steam belongs to the French author; that if even the machine of his competitor ever existed, it was, according to all appearances, the apparatus described nearly half a century before in the work entitled *Raisons des forces mouvantes*; it is to be supposed that future historians will not fail to inscribe the modest name of Solomon de Caus, wherever, up to this time, that of the Marquis of Worcester has taken precedence.

#### 1683. *Sir Samuel Morland.\**

If I were only to speak in this memoir of those persons whose works have contributed either to create or to improve steam machines, the name of Sir Samuel Morland would be omitted altogether; but this name being on the lips of almost every author in England who has treated of the steam engine, I cannot well omit mentioning it myself, if it were only for the purpose of justifying the opinion which I am about to advance. There is in the British Museum a very beautiful manuscript of Sir Samuel's, entitled, The elevation of water by all kinds of machines, reduced to measure, weight, and level; presented to his most Christian Majesty by the Chevalier Morland, gentleman in ordinary of the privy chamber, chief machinist, and master of mechanics of the king of Great Britain.† In this manuscript of thirty-eight pages, the article relating to the steam machine only occupies four pages, and is distinguished from the rest by a particular title. Here is the para-

\* Sir Samuel Morland, as well as Worcester, took an active part in the events of the civil war. Cromwell employed him in many diplomatic missions. His countrymen assure us, that he was, at the same time, secretary to Thurlow and notoriously a spy of the king. At the restoration, Charles II made him a baronet. Morland employed himself in various questions of acoustics, among others, of the best shape to give the speaking trumpet. He died at Hammersmith in the month of January, 1696, after having conceived the odd idea of causing a large collection of works on music which he possessed to be buried six feet deep, in token of repentance for his past life.

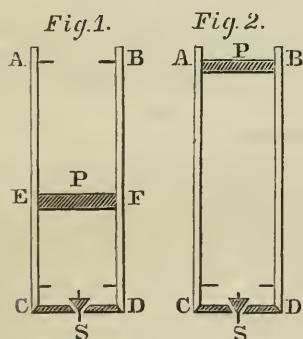
† There exists one of Morland's works, *printed* in Paris in 1685, which has nearly the same title as the manuscript of the British Museum. The chapter relating to the steam engine is wanting. The author only, in enumerating, in his preface, all the

graph upon which the pretensions of Morland as a contributor to the creation of the steam engine are founded in England:—

“Water being evaporated by the action of fire the steam thus produced requires immediately nearly 2000 times greater space than the water occupied before, and sooner than remain confined would burst a piece of ordnance. When subjected, however, to the laws of statics and reduced by science to measure, weight and equipoise, then it will bear its burden like a good horse, and will thus become of great use to the human race, particularly in the raising of water, according to the following table which marks the number of pounds which may be lifted 1800 times an hour at six inches of lift, by cylinders half filled with water, as well as the diameters and depths of the said cylinder.”

If Morland's work had preceded those of Solomon de Caus or of Worcester, the passage which I have just read would constitute a true claim. In 1683, that is to say, sixty-eight years after the publication of *Raisons des Forces mouvantes*, and twenty years after the date of Worcester's patent, Morland's plan could be only considered as a plagiarism. Be it said, however, to the honour of this mechanician, that the numbers which he gives to express the relative bulk of water and of an equal weight of steam, come nearer to the truth than might have been expected from experiments made in 1682.

1690 and 1695. Denis Papin.\*



Let us imagine a large vertical cylinder A, B, C, D, fig. 1, entirely open on the upper part, and resting upon a metallic base, furnished with a valve capable of opening from below upwards at pleasure. Let us place a movable piston P in the middle of the cylinder closing its opening very exactly. The atmosphere will press with all its weight upon the upper surface of this piston, and will force it from above downwards. If the valve S, is open, that portion of air with which the space D, C, E, F, is filled, will tend, on the contrary, by its reaction to raise the piston again. This second force will be equal to the first, because in a gas, as well as in a fluid, the

various motive powers which the mechanician brings into play, mentions the force of gunpowder and that of steam, without making any remark on this subject, by which we may infer whether he sets himself up as an inventor, or speaks of a thing already proposed by others.

\* Denis Papin was born at Blois. In his youth he devoted himself to medicine and took his degrees in Paris; afterwards he crossed over to England where Boyle, who had associated him with some of his experiments, caused him to be nominated a member of the Royal Society in 1681. Being obliged to expatriate himself by the revocation of the edict of Nantes, Papin took refuge in Germany, under the protection of the Landgrave of Hesse, and filled with distinction for many years, the situation of Professor of Mathematics in the university of Marburg; he died in 1710. It must be considered as singular that the academy of sciences at Paris should not have named Papin one of their associates, when we reflect that in 1690 he published a memoir in which is found, as we shall see directly, the most methodical and the clearest description of the steam engine known at present under the name of the *Atmospheric Engine*, and even of that of *steam vessels*. A man of genius, no matter in what line, is always despised when he is in advance of the age in which he lives.



pressure in each point is the same in all directions. The piston thus acted upon by two opposing forces, which balance each other, will, nevertheless, descend, but only by its own weight. Any effort then, however small, if superior to this same weight will be sufficient to raise the piston to the top of the cylinder and keep it there. Let us suppose that in fact the piston is thus brought to the end of its course, as it is represented in fig. 2, and let us try to make it descend. A very efficacious way would consist in shutting the valve S, and afterwards, if it were possible, to annihilate suddenly and entirely in the cylinder that portion of air which occupies the space A, B, C, D. Then the piston would only be subject to the action of the outer air by which it is pressed. This impulse would be exercised on its upper surface, from above, downwards, and would be in measure, equal to a cylinder of water of thirty-three feet in height, the base of which would be equal to that of the piston, or, which amounts to the same thing, to the weight of a cylinder of mercury of a similar base, and thirty inches only in height; for such is the weight of the atmosphere. The piston would then descend necessarily, and could even drag with it a weight equal to that of the cylinder of water or of mercury of which I have just spoken. Following still the same hypothesis, let us admit that at the instant in which the descending movement is completely accomplished, the valve S is opened. The air will operate from below and will counter-balance the action of the air above. A trifling impulse will then suffice to force the piston back to the top of the cylinder and to bring back every part of the apparatus to its first position. A second exhaustion of the inner air would cause the piston to descend again, and so on in succession.

To recapitulate:—in this apparatus, a small expenditure of power is sufficient to raise the piston, whilst its descending motion is capable of producing a considerable effect. If a cord is attached by one end to the centre of the piston, and the other end is passed over a pulley, we may at each descending motion raise a very great weight, equal in amount to the height of the cylinder. With a cylinder one hundred square inches in area the weight raised at each descending stroke of the piston, would be 1500 pounds.

The idea of the machine of which I have just spoken belongs to Papin. It is very clearly explained in the Acts of Leipsic, for the year 1688, p. 644, and subsequently with some new developments in a letter to Count William Maurice. (See the work printed in Cassel, in 1695, and entitled: *Recueil de diverses pièces touchant quelques nouvelles machines*, p. 38 et seq.) It now remains for us to make known the means by which Papin proposed to exhaust, at the proper moment, the atmospheric air which, collected under the piston, would hinder its descending motion, or, what amounts to the same, it remains for us to explain how he made, at pleasure, a vacuum in the lower part of the cylinder.

This philosopher thought for some time of employing for that purpose a hydraulic wheel which would have set the piston of a common suction pump in motion. When the water course employed to set this wheel in motion should be too far from the machine, he proposed to connect it with the pump by the intervention of a continuous tube, like the gas pipes of our days: this was, he said, *a means of transporting water power from a distance*. [*Un moyen de transporter fort loin la force des rivières.*]

In this state, in 1687, the machine was presented to the Royal Society of London, where it gave rise to some difficulties which Papin mentions, without saying, however, in what they consisted. (See *Recueil*, p. 41.) He

had tried previously to make the *vacuum* under the piston by means of powder; but "notwithstanding all the precautions which have been observed," says he, "there has always remained in the tube about a fifth part of the air which it usually contains, which causes two different inconveniences. One is, that half the power which we ought to obtain is lost, so that we could only raise one hundred and fifty pounds to every foot in height, in place of three hundred pounds which ought to be raised if the tube had been perfectly emptied; the other inconvenience is that in proportion as the piston descends, the power which pushes it down diminishes more and more, etc. (*Recueil*, etc., p. 52.)

"I tried then, he adds, to succeed in another way; and as water being changed by fire has the property of becoming elastic as air, and afterwards of recondensing itself so completely BY COLD that it retains no appearance of this elastic power, I have thought that it would not be difficult to construct machines in which, by the means of a moderate heat and at little expense, water would create this perfect vacuum which has been fruitlessly attempted by the means of gunpowder."

This important paragraph is found in the 53rd page of the collection, printed at Cassel in 1695, as extracted from the Acts of Leipsic, of the month of August 1690. It is followed by the description of the little apparatus which Papin made use of to try his invention. The body of the cylinder was only two and a half inches in diameter and weighed but five ounces. At every vibration it raised sixty pounds, however, a distance equal to that of the descending stroke of the piston.

When the fire was removed, the steam disappeared so completely that the piston to which it had given the ascending motion "redescended to the very bottom, so that it could not be suspected that any air remained to act on it from below and resist its descent." (*Recueil*, p. 55.)

The water which furnished the steam in these first experiments, was not contained in a separate boiler, it was contained in the body of the cylinder itself, resting upon the metallic plate which closed it below. Papin heated this plate directly to convert the water into steam; and cooled it by removing it from the fire when he wished the steam to condense. He relates that with a moderate fire, a minute was long enough, in the experiments of 1690, "to drive the piston in this way to the very top of its tube." (*Recueil*, p. 55.) But in the experiments which he afterwards made he emptied the tube in a quarter of a minute.

Moreover, he himself declares that setting out from the principle of the condensation of steam by cold, the end proposed may be attained "by different constructions easy to imagine." (See the *Recueil*, p. 53.)

The machine of Solomon de Caus and that of the Marquis of Worcester were intended for draining. Such also was the principal use which Papin expected to derive from his atmospheric pressure engine; but at the same time he saw perfectly that the reciprocating motion of the piston in the cylinder was capable of other applications and might become an universal motor. We find, in fact, in page 58 and 59 of the *Recueil*, and even before it in the Acts of Leipsic of 1690, a plan for converting this alternate movement into one of rotation. I will not dwell longer here upon this subject since we shall have to resume it further on in treating of steam vessels, and I will finish with Papin by presenting to the reader the various consequences which appear to me to flow from the extracts which we have just read.

Papin conceived the first steam engine with a piston.



Papin first observed that aqueous vapour furnished a simple means of rapidly creating a vacuum in the space contained in the cylinder.

Papin is the first person who thought of combining in the same machine operating by fire, the action of the elastic force of steam, with the property which steam possesses, and which he has described, of condensing by cooling.\*

1698. *Captain Savery.*

We have no proof that Solomon de Caus ever caused his steam engine

\* Messrs. Stuart and Partington have explicitly recognized all these claims of Papin to the gratitude of mechanicians; but, by way of equivalent, those who read Dr. Robison's History of the steam engine (see the last edition with the comments of Watt) will there find, p. 49, that the *first publication* of Papin upon steam machines appeared in 1707; that this machinist did not propose to employ a true piston but a simple float; that he had never dreamed (and here was the important point) of producing the descending motion of the piston by the condensation of steam. These declarations are also made in Dr. Rees' Cyclopaedia, article Steam Engine. The author of this article has read in the Acts of Leipsic, a description of the machine in which Papin attempted to produce a vacuum by the aid of gunpowder, for he quotes it; but, by a singular fatality, the mention inserted in the same Acts, of Papin's substituting steam for powder did not attract his attention, since he declares that the apparatus of the French machinist was never *intended to be worked by steam*.

Mr. Millington is hardly more favourable to our countrymen whose ideas, he says, upon the means of producing a motive power by the aid of steam are all posterior to Savery's patent (p. 255); (Savery's patent was issued in 1698.) Mr. Lardner assures us equally in the lectures which he has recently published, that the French ground their pretensions to the invention of the first steam engine, upon a work of Papin's which did not appear until 1707, nine years after the date of Savery's patent. This remark, he adds, settles the question entirely; Papin has no right to any share in the invention of the steam engine. (*Voyez Leçons Sur la machine à vapeur*, p. 96, 97, et 101 de l'édition française.)

Is it not really singular that the greater part of the English authors persist in this way in citing only one of Papin's works, that of 1707; that they will make no account of the much more voluminous work from which I have borrowed several passages, and of which two editions appeared in the same year, 1695, one at Cassel in French, and the other at Marburg in Latin; that all the records of this author inserted in the Acts of Leipsic appear to them as if they had never existed!

I will grant, if they will, that there was no piston, properly so called, in the *draining* machine of 1707; that the condensation of steam had nothing to do with it; that, at all events, the machine is of posterior date to Captain Savery's patent; but these concessions lead to no conclusion, since we do not cite the work of 1707, but a collection of 1695, and the Acts of Leipsic of 1690. Bossut derives his authority, in his *Hydrodynamique*, for attributing to Papin an important part in the invention of the steam engine, from the work of 1695; Robison answers that this work does not exist! ("The fact is that Papin's first publication was in 1707.") I might conceive of a declaration that he had never seen it, but this flat denial, opposed to the positive assertion of Bossut, was the more strange, because Papin's book is not scarce in England, and because, at all events, the Acts of Leipsic which contain the substance of it, are to be found in the principal libraries, and finally because this work, the existence of which is denied by the celebrated Edinburgh professor, was announced and reviewed in March 1697, in the *Philosophical Transactions*, a year before any thing was said about Savery's engine. It should not be forgotten that the review of the *Philosophical Transactions* gives, in another place, that passage in Papin's work which relates to the employment of steam, in the first place as a means of working the piston, and afterwards as a means of creating a vacuum in cylinders. (See Trans. vol. XIX, p. 483.)

to be constructed. I might say as much of that of the Marquis of Worcester.\* Papin's machine, in which the action of steam and its condensation came successively in play, was only executed on a small scale, and only with the view of establishing experimentally the accuracy of the principle upon which it is founded.†

Moreover, although, properly speaking, there may be nothing very new in Savery's steam engines, they could not without great injustice be passed over since they are really the first which were probably in operation. Moreover, I do not think it necessary here to give a drawing of them: the reader can, without this assistance, form an exact idea of them if he will recall to mind that of Solomon de Caus and pay some attention to the following considerations. According to de Caus' plan, the steam which was to give the power would be generated in the vessel which contained the water to be raised, and at the expense of this same water. In Savery's machine, there are two separate vessels; one contains the water, the other, which might be called the *boiler*, contains the steam. This steam, when it is thought to be sufficient in quantity, is admitted into the upper part of the vessel of water through a communicating tube which is opened at pleasure by the aid of a cock. It acts downwards upon the surface of the liquid and drives it into a vertical tube, the lower opening of which ought to be always situated below this surface, otherwise the steam would escape through it. Up to this point the difference between the two machines is insignificant; let us continue the comparison.

In the machine of Solomon de Caus, as soon as the pressure of the steam has produced its effect, a workman replaces the expelled water by means of an orifice situated in the upper part of the metallic sphere, and which can be opened or closed at pleasure. Nothing more remains to be done then but to increase the fire. In Savery's machine, the vessel which is to contain the liquid is not supplied by a workman, but by means of atmospheric pressure. The steam driving before it, during the first period of its action, the water which the vessel contained, takes its place; now, the steam, whatever may be its original elastic power, must be condensed, in a great measure, if its temperature be much lowered. It is sufficient for this purpose, and such in fact is the process adopted by Savery, to throw cold water upon the sides of the vessel, containing it. After this operation, the atmospheric pressure easily surmounts the barely perceptible elasticity which the cooling has not annihilated, and if the vessel communicates by a

\* The privilege solicited by the Marquis of Worcester was granted him according to Walpole, *upon the simple assurance* which he gave the commissioners named for this purpose, that he had invented a machine operating by the action of steam. If the machine had been really constructed, the remark relative to the declaration, as Mr. Stuart observes, had not been necessary. I am not ignorant that ultimately, it has been pretended, on the contrary, that the bill solicited by Worcester was the object of a long and minute examination, but to annul the evidence of Walpole it would have been necessary to prove that the commissioners appointed by Parliament had seen a machine in operation, or at least a model, and so far nobody has pretended this to be the case.

† The Count of Sinzendorff, owner of several inundated mines in Bohemia, wanted Papin to go and drain them with his machine; but the unfortunate circumstances in which Germany was placed at that time prevented him from removing. "I should desire extremely, said he, to render my humble services to your excellency, were it not that the ruined state of the country in our neighbourhood, and the uncertainty of the events of the war, warn me that I ought not to leave my family at such a distance, and at a time like this." (*Recueil de diverses pièces, etc.*, p. 49.)

tube, with a sheet of water, the level of which is not more than from 25 to 30 feet below, it will fill itself by suction. In adding that, to avoid intermissions in the supply of water, Savery employed a third vessel, which filled with liquid, while the second was emptying, and reciprocally, that the second and third vessel were, *one after the other*, in communication with the boiler, by the assistance of a convenient system of tubes and cocks, I shall have noticed every thing essential in this engineer's machine.

Solomon de Caus' apparatus has been found fault with, for only raising the water while *hot*. This reproach, it must be admitted, has some weight, in reference to economy, but it applies also, to a certain point, to Savery's engine. In this machine in fact, the steam proceeding from the boiler before acting upon the surface of the water of the second, or the third, vessel, is condensed in considerable quantities. Its elasticity does not become efficacious until after the water has acquired a high temperature: therefore when the water begins to rise, it is *hot*.\* Robison said he had ascertained experimentally, that in employing steam as Savery did, at least  $\frac{1}{2}$ ths is condensed, either by the sides of the second, or third, vessel, or by the water which they contain; even when the pressure is small. In an analogous machine, to avoid the enormous waste of steam, of which I have just spoken, Papin thought of interposing a piston or float, (*flotteur*).† This contrivance was not adopted, less, I think, on account of the difficulties in executing it, than on account of very serious defects inseparable from this kind of machine. To raise water to the inconsiderable height of 65 metres, (200 feet;) for example, Savery was obliged to raise the steam of his boiler to six atmospheres; hence, the continual derangements of the joints, hence, also, the melting of the cement, and even dangerous explosions. Moreover, in spite of the title of his work, the machines of this engineer served no useful purpose in the mines. They were only used to distribute water through various parts of the palaces, or of country seats, in parks or in gardens, wherever, in a word, the difference of level to surmount did not exceed some forty feet. With the assistance of the machine proposed by Papin, there is no height, on the contrary, to which water might not be carried, even in using a very low pressure of steam: for this purpose it is only necessary to give a sufficiently large diameter to the cylinder.

To sum up, Savery tried to make use of the elastic power of steam, to

\* In fact, merely a thin stratum of hot water is formed by the condensation of the steam, and Savery's engine by no means raises *hot water*, as asserted by M. Arago; a very similar engine to Savery's, has recently been put up in one of the slaughter houses (*abattoirs*) of Paris to raise water!

TRANS.

† Mr. Robert Stuart believes that in introducing a float in the body of the cylinder, Papin's object was not to hinder the condensation of steam. (See a Descriptive history, 2d edit. p. 52.) Papin nevertheless explains himself very clearly upon this subject, and we shall even see by the passage, which I find in page 26, of the work published in 1707, how forcibly this defect struck him:

"I remark that the steam which passes into the pump to drive the water out of it, meets in the machine, (Savery's) cold water which condenses it, and makes it lose the greater part of its force. . . . It is only after the water is heated that we can expel it . . . ; to heat the water in this way a great deal of steam must be consumed. It is necessary, therefore, frequently to replenish the boiler with fresh water, and it requires a great deal of time, and of wood to heat it again. But by means of our piston, (*flotteur a deux fonds*) the steam encounters always the same surface of metal, which soon acquires such great heat that the steam loses little or nothing of its force by the contact."



drive up water in a vertical tube; but Solomon de Caus had done it precisely in the same way, eighty-three years before. Savery filled the vessels in which the steam was afterwards to operate, by suction; but suction was not a new principle in 1698, since the "*abhorrence of a vacuum*" had been very anciently invented to explain it, and because we find elsewhere applications entirely similar to those of the English machinist, in the *Raisons des forces mouvantes*; suction at the most, added very little to the value of the machine, for it increased only by some thirty feet the height to which the liquid would have been raised without its aid. Savery, at length, caused the vacuum which produced the suction, by *condensing the steam*; here the method is important, but Papin had published it long before. The patent granted to Savery is dated 25th July, 1698; the trials of his machine before the Royal Society, took place in the month of June, 1699; the first edition of the *Miner's Friend* is dated in 1702, thus Papin's titles have a priority of three years, even if setting aside the Acts of Leipsic, we only go as far back as the *Recueil*, in which several memoirs of this machinist are found, for this work was published in 1695. What then is left to Savery? The honor of having first *executed* on rather a large scale, a steam draining machine, and if you please, that of having caused condensation by the affusion of cold water on the outside of the metallic vessel containing the steam. In describing for the first time this ingenious method of producing a vacuum, Papin, in fact, neglected to explain the *different constructions easy to imagine*, (these are his expressions) which *may be employed* to attain this end. During his experiments with a small cylinder, he contented himself, as we have seen with removing the fire.

#### 1705. *Newcomen, Cawley, and Savery.\**

The draining machine known to artisans by the name of *Newcomen's engine*, or, the atmospheric engine, was the first which rendered any essential service to art. I will observe indeed, that in a great many places where coal is not dear, it is still in use, and that it has not been found profitable to replace it. This machine, finally, excepting some details in its construction, which I shall notice farther on, *is none other* than the machine proposed in 1690, and 1695, by Papin, and which he tried on a small scale. In both, we remark, in fact, a vertical metallic cylinder closed at the bottom, open at the top, and having a well adjusted piston intended to work through its whole length. In both, the ascending motion of the piston works by the effect of a counter-poise, when the steam can come freely into the lower part of the pump and fill it. In the English machine, as well as in Papin's, as soon as the piston reaches the end of its ascending course, the steam which has forced it there is condensed, and in this way a vacuum is made in the space through which it has just passed, and the atmosphere forces it then to descend. Papin announced that this condensation must be effected *by cold*; and it is by cold that Newcomen, Cawley, and Savery, also get rid of the steam which would counter-balance the atmospheric pressure. *Among many different constructions which may*

\* Thomas Newcomen and John Cawley, both lived in the town of Dartmouth, in Devonshire. The first was an iron monger or a black smith, for he is mentioned as exercising both of these trades in the English biographies; the latter was a glazier. Newcomen was a man of some education, and was in correspondence with Hooke, Secretary to the Royal Society, and one of the most ingenious *Savants* of whom England may boast. We are ignorant whether the two associates took an equal part in the various experiments which led to the construction of the first large atmospheric engine.



be imagined for this purpose, (this is the expression contained in the *Recueil de pièces*, p. 53,) the English machinists have adopted one, much preferable in a large machine, to that which Papin himself used in the experiments made with his little model. In the place of removing the fire as Papin did, Newcomen, Cawley, and Savery, caused an abundant quantity of cold water to flow into the annular space comprised between the outside of the cylinder and a second cylinder rather larger in size, which enveloped it. The cooling communicated itself in this way gradually to the whole thickness of the metal, and soon reached the steam itself.

Papin's machine, thus modified as to the mode of cooling the aqueous vapor, excited the attention of proprietors of mines in the highest degree, and appeared, from the beginning, to furnish an unhoped for solution of the problem of which the fruitless attempts of Savery had particularly shown the difficulty. Newcomen, and Cawley, solicited a patent. Savery objected that he was already in possession of an exclusive privilege with regard to the means of producing a vacuum by condensing the steam. To avoid all dispute, the patent was taken out in the name, and for the advantage of the three competitors, who in this way attributed to themselves, in the plan borrowed from Papin, the two first the idea of the steam engine with a piston, and the third that of condensation.\* At the commencement of the 18th century, the art of constructing large and perfect cylinders, and the art of fitting to them movable pistons, which close them hermetically, had made very little progress. Thus, in the machine made in 1705, to prevent the steam from escaping through the interstices comprised between the surface of the cylinder and the piston the upper surface of this piston was continually covered by a layer of water which penetrated into, and filled all the hollows.

One day while a machine of this description was in operation under the eye of the constructors, they saw, with extreme surprise, the piston descend several times in succession much more rapidly than usual. This rapidity appeared the more strange to them, as the refrigeration produced by the current of cold water which descended along the outside surface of the body of the cylinder, had so far been rather slow in producing the condensation of the steam on the inside. Upon verifying the fact, it was proved that on this occasion, the phenomenon was attributable to an entirely different cause: the piston having accidentally a small hole in it, the cold water which covered it, passed *into the inside of the cylinder itself, in a jet, across the stream*, cooled it, and consequently condensed it faster.

From this period, atmospheric engines were provided with an opening like the mouth of a watering pot; from this proceeded a shower of cold water, which spread in the interior of the cylinder, and there condensed the steam at the moment in which the piston was about to descend. The exterior

\* In the arts, as in the sciences, the last comer is supposed to be acquainted with the labors of those who preceded him. All denial in this respect is without value. The publication of the memoirs written by Papin upon the atmospheric engine, being much anterior to the patents granted to Savery and Newcomen, I shall have no motive for investigating whether the English machine is, or is not a copy: according to rule, it is a copy since it is like Papin's machine, and because it followed it. But we know moreover, in this particular instance, that Newcomen was acquainted with the plans of our countryman! It results, in fact, from various notes found among Hooke's papers, that the Dartmouth artist had consulted this famous *Savant* before beginning his experiments, and then, in the confidence of intimacy it was really the French engine which he wanted to construct. (See Robison *A System*, &c. vol. 11, p. 58.)

cooling was in this way suppressed, and the strokes much quicker. This important improvement, like many others which might be cited, was the result of a fortunate accident. I regret very much not being able here to point out which of the three associates it was whose inventive mind saw directly, in the unexpected event of which I have given an account, the principle of an improvement which is still found in the engines of the present time; but tradition gives us no information upon this subject.

[TO BE CONTINUED.]

*Notices of the advancement of Mineralogy in 1837, from Berzelius Jahresbericht.*

(Continued from Vol. XXIV, page 367.)

In the former report p. 206, I mentioned two of the new minerals analysed by Thomson, one of which was said to consist of  $2(\text{CaO} + \text{CO}_2) + (\text{BaO} + \text{CO}_2)$  and the other of one atom of sulphate, and two atoms of carbonate of baryta. Johnston\* repeating the analysis, found the former  $(\text{CaO} + \text{CO}_2) + (\text{BaO} + \text{CO}_2)$  and the latter  $\text{BaO} + \text{CO}_2$  or a simple carbonate of baryta. Thomson† again repeated the analysis of the former, and although this formula differs from his first, yet it varies from that of Johnston, being represented by the formula  $(\text{MnO} + \text{CO}_2) + (4\text{CaO} + \text{CO}_2) + (4\text{BaO} + \text{CO}_2)$ , or one part carbonate of manganese with four parts each of the carbonates of lime and baryta. The identity of its crystalline form with that formerly given for the same compound, favors the results of Johnston. It will be interesting to see how many of the results of Thomson's analyses presented in my last report, will stand the test of the experiments of other chemists!

Sheppard‡ examined a protophosphate of cerium (Edwardsite) which occurs in Gneiss, in Norwich, Connecticut. It forms crystals, with an oblique rhombic prism as its radical; the small prisms generally present pyramidal terminations. It is hyacinth red; gives a white streak; is translucent—transparent; sp. gr. 4.2—4.6. It is found in crystals from  $\frac{1}{6}$  —  $\frac{1}{3}$  of an inch in breadth. Before the blow pipe it becomes pearl-gray with a yellowish tint, and fuses on the edges to a transparent glass. Analysis gave:

|                                                 |   |              |
|-------------------------------------------------|---|--------------|
| Protoxide of cerium,                            | . | 56.53        |
| Phosphoric acid,                                | . | 26.66        |
| Zirconia,                                       | . | 7.77         |
| Alumina,                                        | . | 4.44         |
| Silica,                                         | . | 3.33         |
| Traces of glucina, magnesia, and oxide of iron, |   |              |
|                                                 |   | <hr/> 98.73. |

The proportion of phosphoric acid to oxide of cerium is represented by  $(\text{CeO})^3 + (\text{P}^2\text{O}_5)$ .

Copper-mica from Goslar was examined by Borchers.§ It is a pale, sometimes gold-yellow, artificial mineral product of a metallic splendid lustre, in the form of very thin, micaceous, six sided tables, occurring in an inferior kind of copper, called by the workmen mica-copper, and remains after dissolving the copper in nitric acid. This peculiar product consists of:

\* L. & E. Phil. Mag. X, 373.

† Ditto, XI, 45.

‡ Journal für Pract. Chem. XII, 185.

§ Poggend. Annal. XLI, 335.

|                  |        |
|------------------|--------|
| Oxide of copper, | 44.278 |
| “ Nickel,        | 30.612 |
| “ Antimony,      | 25.110 |

The oxides of copper and nickel together, appear to contain four times as much oxygen as that of antimony.

*Damur*\* analyzed a vanadate of lead, the locality of which was unknown. It sits on quartz, forming brownish-yellow warts, which are dark green on their fractured surface, but yield a pale yellow powder. It contains:

|                   |        |
|-------------------|--------|
| Chloride of lead, | 8.889  |
| Oxide of lead,    | 63.725 |
| “ Zinc,           | 6.345  |
| “ Copper,         | 2.960  |
| Vanadic acid,     | 15.860 |
| Water,            | 3.800  |

---

101.579

*Apjohn*† analyzed a mineral from Africa, which occurs in snow-white fibres with silky lustre, about 6 inches in length, and ascertained its composition to be  $(\text{MgO} + \text{S}^{\text{O}^3}) + (\text{Al}^2\text{O}^3 + \text{S}^3\text{O}^9)$ . It is therefore an alum, in which the potassa is replaced by protoxide of manganese.

*Von Holger*‡ has undertaken to enrich the science of mineralogy with an entirely distinct branch, of which no one would previously have dreamed, viz. with a “Pathology of the mineral kingdom.” In order to have a Pathology, minerals should also possess vitality. “No one,” says V. Holger, “now views minerals as lifeless bodies, in contradistinction to living, organic beings, but it is believed that they possess life like the latter, although it is of a different kind. They must then exert vital energy, &c.” He proceeds from this introduction to the *Diseases of minerals*, which constitute mineral Pathology, and attempts to show that they may be diseased in regard to their composition, their form and their origin. What was said by a philosopher about 2000 years ago still holds good, that nothing is so absurd, but it may at some day be asserted and maintained by the learned !

The present number closes the extracts from Berzelius’ Report, for the year 1837, and should it be deemed of sufficient interest to the readers of the Journal, the committee will endeavor to introduce similar notices from the Report of 1838, which is at present in the course of publication in Germany.

## Civil Engineering.

*On the Mensuration of Excavation and Embankment, upon Canals, Roads, and Rail Roads.* By ELLWOOD MORRIS, Civil Engineer.

On directing the attention to Public Works, one is immediately struck with the vastness of the amount of money expended in Excavation, Embankment and Masonry: forming on the Roads and Rail Roads, usually the chief, and on the canals nearly the only items of outlay. We have the authority of the Chev. de Gerstner, that the 3000 miles of railway this year

\* Journ. für Pract. Chemie. XI, 134. † Annal. der Pharmacie, XXII, 272.

‡ Zeitschrift für Physik von Baumgärtner & Ritter, v. Holger, V. 159.



in operation in the United States, cost sixty millions of dollars.\* Of which, perhaps, forty millions were laid out in the graduation and masonry alone.

When to this, we add the immense expenditures for similar objects upon the Canals and Roads of the Union, will it be too much to say that near one hundred millions of dollars have been disbursed in the earth works, requisite to reduce the routes to proper levels, and the architectural constructions necessary to pass the streams.

This large amount of work having been done chiefly by contract, and paid for by the cubic yard, or perch, the vast importance of accuracy and uniformity in calculating the contents of Excavation, Embankment, and Masonry solids, must be palpable to all. Unfortunately, great diversity has existed, and still continues to exist, in the modes of mensuration adopted by Engineers; they may, however, in a general way, be divided into two principal methods, and the modifications which flow from them; first, those which depend on arithmetical, and, second, those dependant on geometrical, average.

When we state that neither of these modes is exact, except in a limited number of cases, we merely mention what is well known to every engineer: but which is a reason not the less powerful, to induce us to seek more perfect methods.

The importance of this subject will, we trust, be a sufficient apology for laying before the readers of the Journal of the Franklin Institute a few observations, with the hope of drawing to it the attention of abler minds.†

We are aware, that it is urged by some, that the modes of measurement are immaterial, provided, the values of the unit of measure computed in a particular mode were known, and that mode generally adopted; and this argument would have great force if any single rule or method of mensuration was used in general practice: But whilst on some works the mode of computation uniformly errs in excess, on others it probably errs in deficiency, or, otherwise, according to circumstances; and this brings us back to the importance of a uniform and more exact mode.

The surface of the ground is regarded by the Engineer, as being composed of planes, variously disposed with relation to each other; so that any vertical section, will exhibit a rectilinear figure more or less regular. This supposition, though not strictly correct, is sufficiently accurate for practical purposes, and avoids any necessity of entering into the complex calculations pertaining to warped surfaces.

The usual method of measuring excavation and embankment, is by taking vertical sections, perpendicular to the centre line of the canal or road, and at short distances apart, in which the elevation or depression of numerous points in the ground, above or below the bottom of canal or grade of road, is ascertained by the spirit level and rod, whilst their distances out, right and left, are measured (generally) with a tape line.

These elevations or depressions are commonly called *plus* or *minus cuttings*, or simply *cuttings*, and the distances of the several points from the centre line are denominated shortly *distances out*. The *cuttings* then are ordinates or perpendiculars drawn from the plane of grade or bottom, to intersect the surface of the ground; and the *distances out*, are the horizontal distances of those perpendiculars from the centre line, (measured at right

\* See Journal Franklin Institute for September 1839.

† A Treatise on the Mensuration of Excavation and Embankment, from the pen of a Northern Engineer, well able to manage such a subject, was lately announced as being in the press, it has not however (the writer believes) yet been published.



angles) and which, by deduction, give the distances apart of the separate cuttings, or the abscissa of those ordinates.

The details of the operation of *taking the cuttings* require great nicety, but are so well known to practical Engineers as to render unnecessary a description at length. We may, however, mention a general rule which must not be neglected if accurate results are desired; viz: At every change of slope transversely, single cuttings, and distances out, must be taken, and at every longitudinal change, sections of cuttings.

Upon rough ground it is customary to make the lateral distances apart of the cuttings uniformly ten feet, which materially facilitates the subsequent calculations. We may here observe that the cuttings and distances out, are commonly taken in feet and tenths, and the regular stations of one hundred feet, are divided by cross sections (or sections of cuttings) into shorter lengths if the ground requires, as it almost always does.

Some Engineers have suggested the division, and we believe some have had their rods and tapes divided, into yards and decimals; and some retaining the rod and tape as usual, have made their regular stations fifty four feet, and have spaced their cross sections where they required to be nearer, so that their distances apart should be some aliquot part of 54 feet. These methods, though they somewhat expedite the office work where the quantities are ascertained by the process of arithmetical average, are not, however, generally adopted by the profession: A foot being usually the unit of lineal measure, a hundred feet a regular station, and the cubic yard the unit of the solidity of excavations and embankments.

The isometrical diagram, fig. 1, Plate 1, represents a regular station of embankment on irregular ground, with an intermediate cross section at 50 feet or midway. Base or width of road surface = 30 feet, slopes 2 to 1, *a*, *b*, *c*, *d*, *e*, *f*, and *g*, are cuttings, *minus cuttings*, in this case: 1: 2: and 3: are the sections of cuttings, or cross sections. *C, C*, is the centre line.

Earth work on Roads and Canals is usually laid off in divisions called *sections* of half a mile or more in length, and when a sufficient number of transverse sections of the ground have been obtained, or technically when the "*cuttings are taken*," the transverse profiles or cross sections are drawn upon paper, their areas calculated, and the solid contents of the excavations and embankments computed; generally by one of two rules, viz:

No. 1: *By Arithmetical Average*.—Multiply the sum of the end areas by their distance apart, and divide the product by 6 and by 9; the result will give, *approximately*, the number of cubic yards in the given length of excavation or embankment.

No. 2: *By Geometrical Average*.—Multiply the sum of the end areas, and the square root of their product, by the distance apart, and divide the product by 9 and by 9. The result will be, *nearly*, the number of cubic yards in the given length of excavation or embankment.

Of these rules, No. 1: gives a result always in excess, except when the excavation or embankment solid, happens to be a prism or cylinder, or when the sums of the right and left distances out, are the same for both the end areas used.

And, No. 2: though accurate when applied to prisms, cylinders, pyramids and cones, or their frustra, fails on application to the prismoid or wedge, as well as to embankment or excavation solids, on irregular ground, where the difference is great between the areas of adjacent transverse sections.

Such is a brief sketch of the modes in common use for measuring excava-

tion and embankment on roads and canals; of which we may observe, that the method, (No. 1,) and all others founded upon the same principles, necessarily lead to errors, often of magnitude, and particularly in deducing "deficient embankment," as is very well shown by Mr. Macneill, in the introduction to his excavation and embankment tables published in 1833. It is true, that Engineers in this country would seldom fail to arrive at much closer results than Mr. Macneill has instanced; because, being well aware, that this very convenient rule (No. 1,) always gives results which are in excess in some ratio to the difference of any two areas averaged, they take care to place their cross sections so near together that this difference may be small, and consequently by closely pursuing this course are enabled to reach results proportionally more exact. Indeed, the writer has often known sections of cuttings on sidehill, to be taken but 10 feet apart longitudinally, and in some extraordinary cases amongst rocks even at a less distance.

The rule No. 2: though not liable to so many, nor such strong objections, is still obnoxious to some: and where greater, indeed almost precise, accuracy is attainable without much more labour, we cannot but think it highly desirable, and accordingly propose to develop a method much superior, as it appears to us. But before doing so, the writer distinctly disclaims any attempt at novelty, as to the principles employed; for they have been long known to those versed in mensuration, and have also been applied to the matter in hand by the eminent Engineer before alluded to (J. Macneill, Esq., C. E. &c.,) in his publication in 1833. It is believed, however, that as a *general process*, the mode about to be laid down has not yet been used on any work.

Upon the general supposition that any given length of excavation or embankment is a solid bounded laterally by plane surfaces, and terminated at both ends by transverse sections, or planes, perpendicular to the centre or guiding line of the excavation or embankment; the contents of that solid may be accurately computed by aid of the "prismoidal formula," used by Mr. Macneill, who gives a very good demonstration of it as applied directly to one of the solids under consideration. Mr. Macneill's tables, though carefully made out, and undoubtedly useful in a level country, are unfortunately not of very ready application to common cases, owing to the variable transverse figure of the ground not having been (and which indeed is scarcely capable of being) taken into the account in the tabular arrangement employed by that distinguished practical writer.

The "Prismoidal Formula" referred to, is as follows:

*Parallel sections each perpendicular to the guiding line of the excavation or embankment.*

Let  $b$  = The area of the base, or of a cross section at one end of a given length of excavation or embankment.

"  $t$  = The area of the top, or other end section.

"  $m$  = The area of a section midway between the two, and deduced from them.

"  $h$  = The height of the solid, or perp. distance between the end sections.

"  $= S$  The solidity.

Then the General Formula  $= \overline{b + 4m + t} \times \frac{1}{6} h = S$ .

This is the rule for the capacity of a prismoid, demonstrated in almost every treatise on mensuration. And it is also the General Formula for the mensuration of all solids, whose bases and tops, or edges, lie in parallel

planes, and whose sides are bounded either by planes or right lines; and from it can be directly deduced the common rules for the solidity of prisms, &c., as will be shown hereafter.

\* It applies to a prism or cylinder as a prismoid, (so to speak) of which the two end sections are equal; to a cone or pyramid as a similar solid, one of whose end sections is nothing; and for the same reason it is applicable to the wedge. As the full demonstration of this remarkable property would occupy much space, we prefer the inverse method of deducing from the General Formula, the common rules for the solidity of prisms, pyramids, &c., the truth of which have been already proven by the writers on mensuration; this will be a proof of the general rule, perhaps quite as satisfactory to the reader, and will, at least, have the recommendation of brevity.

$$\text{General Formula} = b + 4m + t \times \frac{1}{6}h = S.$$

### 1. Prisms or Cylinders.

Here  $b = m$ , or  $4m = 4b$ , and  $t = b$ , substituting these values, Gen For: becomes  $b + 4b + b \times \frac{1}{6}h = S$ . or  $6b \times \frac{1}{6}h = S$ , or finally  $b \times h = S$ , which is the common rule, usually expressed thus.

“Multiply the area of the base by the height of the prism, and the product will give the solid content.”

By figures referring to the diagram, fig. 2, Plate 1.

| By General Formula.               | By Common Rule.         |
|-----------------------------------|-------------------------|
| $10 \times 8 = 80 = b$            | $10 \times 8 = 80 = b$  |
| $10 \times 8 \times 4 = 320 = 4m$ | $48 = h$                |
| $10 \times 8 = 80 = t$            |                         |
| <hr/>                             | <hr/>                   |
| 480                               | $b \times h = 3840 = S$ |
| $8 = \frac{1}{6}h$                |                         |
| <hr/>                             |                         |
| 3840 = S                          |                         |

### 2. Pyramids and Cones.

Here  $t = 0$ ,  $m = \frac{1}{4}b$ , or  $4m = b$ , substituting these values the Gen For: becomes  $b + b + 0 \times \frac{1}{6}h = S$ . or  $2b \times \frac{1}{6}h = S$ . or finally  $b \times \frac{1}{3}h = S$ , which is the common rule usually stated in words thus,

“Multiply the area of the base by one third of the height, and the product will be the solid content.”

By figures referring to the diagram, fig. 3, plate 1.

| By General Formula.             | By Common Rule.        |
|---------------------------------|------------------------|
| $10 \times 8 = 80 = b$          | $10 \times 8 = 80 = b$ |
| $5 \times 4 \times 4 = 80 = 4m$ | $16 = \frac{1}{3}h$    |
| $0 \times 0 = 0 = t$            |                        |
| <hr/>                           | <hr/>                  |
| 160                             | 1280 = S               |
| $8 = \frac{1}{6}h$              |                        |
| <hr/>                           |                        |
| 1280 = S                        |                        |

\* This subject is noticed by (I believe) Sir George Head, in a work on England, speaking of a system of Education.

3. *The Wedge.*

Here let  $e$  = length of the edge,  $l$  = length of the back, and  $d$  = depth or thickness of the back.

Then in the general formula,  $t = 0$ .  $b = l \times d$ ,  $m = \frac{l+e}{2} \times \frac{d}{2}$  or  $4m = \overline{l+e} \times d$ , substituting these values, general formula becomes  $\overline{l \times d + l + e \times d} \times \frac{1}{6} h = S$ . Or  $\overline{l \times d + l \times d + e \times d} \times \frac{1}{6} h = S$ . Or, finally  $\overline{2l + e \times d} \times \frac{1}{6} h = S$ . which is the common rule usually expressed thus,

“To the length of the edge, add twice the length of the back; multiply this sum by the breadth (or thickness) of the back, and then by one sixth of the height of the wedge; the product will be the solid content.”

By figures see the diagram, fig. 4, plate 1.

| By General Formula. |                                        |
|---------------------|----------------------------------------|
| 10 × 8 =            | 80 = $b$                               |
| 20 × 4 × 4 =        | 320 = $4m$                             |
| 0 × 30 =            | 0 = $t$                                |
|                     | <hr style="width: 100px; margin: 0;"/> |
|                     | 400                                    |
|                     | 8 = $\frac{1}{6} h$                    |
|                     | <hr style="width: 100px; margin: 0;"/> |
|                     | 3200 = S                               |

| By Common Rule.             |                                        |
|-----------------------------|----------------------------------------|
| 10 × 2 + 30 = 50 = $2l + e$ |                                        |
| 8 = $d$                     |                                        |
|                             | <hr style="width: 100px; margin: 0;"/> |
|                             | 400                                    |
|                             | 8 = $\frac{1}{6} h$                    |
|                             | <hr style="width: 100px; margin: 0;"/> |
|                             | 3200 = S                               |

To the frustra of either of the above solids, the general formula is equally applicable, to prove which we observe, that the frustrum of a prism is still a prism, and the frustrum of a wedge is a prismoid; it only remains then to show the application to

4. *The Frustrum of a Pyramid.*

Here, for the sake of simplifying the demonstration, suppose the frustrum to be of a pyramid having a square for its base. Let  $a$  = a side of the base of the frustrum, and  $c$  = a side of the top. Then in the general formula

$$b = a^2 \quad t = c^2 \quad \text{and} \quad m = \frac{a+c}{2} \times \frac{a+c}{2} \quad \text{or} \quad m = \frac{a+c^2}{4} \quad \text{hence} \quad 4m = \overline{a+c^2} = a^2 + 2ac + c^2.$$

Substituting these values the general formula becomes  $\overline{a^2 + a^2 + 2ac + c^2 + c^2} \times \frac{1}{6} h = S$ . or  $\overline{2a^2 + 2ac + 2c^2} \times \frac{1}{6} h = S$ . or  $\overline{a^2 + ac + c^2} \times \frac{1}{3} h = S$ .

But  $ac = \sqrt{a^2 \times c^2}$  substituting which the formula becomes

$$a^2 + \sqrt{a^2 \times c^2} + c^2 \times \frac{1}{3} h = S. \quad \text{which is the common rule usually expressed thus,}$$

“The sum of the areas of the ends and the square root of their product, multiplied by one-third of the height (or perpendicular distance between the ends) gives the solidity of the frustrum.”

What is true of frustra of pyramids is also true of those of cones, though, owing to the properties of the circle, the rule for the solidity of conic frustra is generally differently stated: it will be observed that the common rule above deduced for pyramidal frustra is identical with rule No. 2, sometimes used to find the contents of excavations and embankments.

By figures see the diagram, fig. 5, plate I.



By General Formula.

$$\begin{array}{rcl}
 20 \times 20 & = & 400 = b \\
 16 \times 16 \times 4 & = & 1024 = 4m \\
 12 \times 12 & = & 144 = t \\
 \hline
 & & 1568 \\
 & & 8 = \frac{1}{6}h \\
 \hline
 & & 12544 = S
 \end{array}$$

By Common Rule.

$$\begin{array}{rcl}
 20 \times 20 & = & 400 = a^2 \\
 \sqrt{400 \times 144} & = & 240 = \sqrt{a^2 \times c^2} \\
 12 \times 12 & = & 144 = c^2 \\
 \hline
 & & 784 \\
 & & 16 = \frac{1}{3}h \\
 \hline
 & & 12544 = S
 \end{array}$$

Now there is no excavation or embankment solid such as we have supposed, that cannot be divided into prisms, prismoids, pyramids, or wedges. or some combination of them, having a common length or height, equal to the distance between the end areas or cross sections. And the height or length being common to all, it will be evident on reflection, that if a given portion of excavation or embankment be composed of any number of the solids named, the area of one end section will equal the sum of the areas of the bases or tops of those solids, the other end area the sum of their tops or bases, and the area of the mid-section will equal the sum of the areas of their middle sections; and, hence, if (as has been proved) the capacities of the separate solids are reducible to one general rule, the solidity of a whole body composed of such solids, and having the height as one common dimension, may therefore be computed by the same rule.

The general process, then, the adoption of which we suggest as a valuable succedaneum to those in common use, will be to compute by the general formula from the sections usually taken in the field, in the following manner : Draw the sections in a book, leaving between each two space enough for the middle section, which will be subsequently deduced from those drawn; on each left hand page should be placed either three sections, (including the mid-section) or some multiple of three, depending on the character of the ground, and the size of the leaf; the right hand page being left open to record the calculations upon. The scale we would recommend to be twenty feet to the inch.

To prevent misapprehension, we will here observe, that in speaking of excavation or embankment, the centre line is always supposed to be a tangent, that being the universal presumption, in practical calculations; although upon curves, owing to the convergence of the cross sections, (they being taken on the radii,) this hypothesis is not exact, and consequently occasions some error, not often, however, of much importance, though cases will sometimes arise (where the primary angle of deflection is unusually large), that ought to receive correction for curvature.

Though not absolutely indispensable, it will be found convenient in using the prismoidal method of calculation, as well as conducive both to expedition and accuracy, to observe the following rules in "*taking the cuttings,*" as far as the character of the surface may admit, viz :

1. On sidehill, at each section of cuttings where the work runs partly in filling, and partly in cutting, ascertain the point where grade or bottom strikes ground surface.

2. On every transverse section take a cutting at both edges of the road, or, at the distance out right and left of one half the base.

3. Always take a cross section, whenever either edge of the road or base passes from excavation to embankment, or vice versa.

4. On sidehill, if the ground admits, take the cuttings (not otherwise provided for) uniformly at ten feet apart.

5. Wherever the ground admits, so place the cross sections as to be at some decimal division of 100 feet apart, as 10, 20, &c.

Excavation and embankment solids, naturally divide themselves into three classes or cases, with modifications, and under one or another of these cases or their modifications, will fall nearly every kind of ground; though on a very intricate surface, such as a rocky hillside, cases may arise, requiring additive or deductive solids, but the Engineer will find little difficulty in managing such, without violating, or interfering with, the general process.

#### Case 1. *Prisms.*

Embankment or excavation, either on level ground, or on ground inclined transversely, and level longitudinally, at the same distance out.

*Modification 1:* all excavation, or all embankment. *Modification 2:* both filling and cutting.

#### Case 2. *Prisms, Prismoids, and Pyramids.*

Embankment or excavation, on ground inclined longitudinally in one plane, and level transversely.

*Modification 1:* all excavation, or all embankment. *Modification 2:* passage from excavation to embankment, or the reverse.

The above two cases do not often exist in practice, that following being of the most general occurrence.

#### Case 3. *Prisms, Prismoids, Pyramids, & Wedges, or a combination of them.*

Excavation or embankment on ground inclined both longitudinally and transversely.

*Modification 1:* all excavation, or all embankment. *Modification 2:* cutting and filling both. *Modification 3:* passage from cutting and filling to either cutting or filling. *Modification 4,* complete passage from excavation to embankment on sidelong ground.

The General Formula admits of a modification, more convenient for use in computing excavation and embankment. It is as follows:

$$\frac{b + 4m + t}{6} \times h = S. \text{ in lieu of } \overline{b + 4m + t} \times \frac{1}{8} h = S; \text{ this modification}$$

we shall employ; and now proceed to give examples in figures of each case, but it may be as well previously, to make some remarks relative to deducing the middle section between any two which have been taken in the field, and sketched in the section book.

To average for the cuttings of the middle section, commence either at centre or at grade, if there be a grade point upon the cross section, and having regard to the inclination of the ground, proceed each way, averaging the cuttings as they occur, for a corresponding cutting of the middle section, and their distances out, or rather their distances apart, for a corresponding distance apart; and if there be more cuttings in one section than in the other, the surplus cuttings (of the same kind) on each side, all average with the *outer* cutting on that side, and their distances apart divided by two (or averaged with 0,) give the corresponding distances of the cuttings which answer to them upon the mid-section. But the averages may be made in any other way demanded by the transverse slopes of the surface, provided all the cuttings are used, and that lines drawn to join any two cuttings averaged, do neither meet between the end sections nor cross. In the mid-

section will always appear the same number of cuttings as are contained in that end section which has the most; and its correctness admits of verification thus,

1.  $\frac{1}{2}$  sum of distances between the extreme cuttings of the end sections, equals the distance between the extreme cuttings of the mid-section. This proves it horizontally : to verify it vertically,

2. Where the number of cuttings of both kinds is the same in each end section,  $\frac{1}{2}$  sum of all the cuttings of the end sections, equals the sum of all the cuttings of the middle section.

3. Where the number of cuttings in the end sections is different, to prove the cuttings of excavation,  $\frac{1}{2}$  sum of the cuttings of the end sections, equals the sum of the cuttings of the mid-section; *minus*, least outer cutting left of centre multiplied by  $\frac{1}{2}$  the difference in the number of cuttings in the end sections on the left; *plus*, least outer cutting right of centre multiplied by the difference in the number of cuttings on the right.

Though this last rule is long in words, it is short in practice, and of course only refers to the excavation or plus cuttings in proving excavation, whilst the same process applied to the minus cuttings will verify the embankment of the middle section.

The exemplifications which will be given apply to the graduation of a road, or rail road, but the principles apply equally to a canal, as the tow path and berm banks above bottom are constant quantities.

In all the following examples the slopes are considered to be the same on both sides of the centre, which is supposed to divide equally the surface of grade, or the base as it will be called. The sections numbered 1: and 3: will uniformly be presumed to be those taken in the field, whilst No. 2: will represent the middle section deduced from the end sections, 1: and 3: the distance between which, will, for convenience, be assumed at 30 feet in every case. Excavations, as to figure, are merely embankments inverted, and hence, as a matter of course, the same principles apply to both.

In all the examples, the results obtained by rules No. 1 and 2, will also be set down for the sake of exhibiting how great in some cases the differences are : the base will be assumed at 30 feet, the slopes at 2 to 1, and C, C, will represent the centre line of the road.

Example of Case 1: Modification 1: fig. 6, plate 1.

$h = 30$ .

| Multipliers. |                                       |   |   | Areas.        | C. Yds. |
|--------------|---------------------------------------|---|---|---------------|---------|
| 1.           | $\frac{30 + 54}{2} \times 6$          | . | . | =             | 252     |
| 2.           | $\frac{30 + 54}{2} \times 6 \times 4$ | . | . | =             | 1008    |
| 3.           | $\frac{30 + 54}{2} \times 6$          | . | . | =             | 252     |
|              |                                       |   |   | 6)1512        |         |
|              |                                       |   |   | <hr/>         |         |
|              |                                       |   |   | 30 × 252      | = 280   |
|              |                                       |   |   | By Rule No. 1 | = 280   |
|              |                                       |   |   | By Rule No. 2 | = 280   |
|              |                                       |   |   | 3*            |         |

*Example of Case 1: Modification 2: fig. 7, plate 1.*

| Embankment.                 |                   |         | Excavation.              |                   |         |
|-----------------------------|-------------------|---------|--------------------------|-------------------|---------|
| Multipliers                 | Areas.            | C. Yds. | Multipliers.             | Areas.            | C. Yds. |
| 1. $15 \times 4 =$          | 60                |         | $15 \times 2 =$          | 30                |         |
| 2. $15 \times 4 \times 4 =$ | 240               |         | $15 \times 2 \times 4 =$ | 120               |         |
| 3. $15 \times 4 =$          | 60                |         | $15 \times 2 =$          | 30                |         |
|                             | 6) 360            |         |                          | 6) 180            |         |
|                             | <hr/>             |         |                          | <hr/>             |         |
| $50 \times 60 =$            | $66\frac{2}{3}$   |         | $50 \times 30 =$         | $33\frac{1}{3}$   |         |
| By Rule No. 1,              | $= 66\frac{2}{3}$ |         | By Rule No. 1,           | $= 33\frac{1}{3}$ |         |
| By Rule No. 2,              | $= 66\frac{2}{3}$ |         | By Rule No. 2,           | $= 33\frac{1}{3}$ |         |

*Example of Case 2: Modification 1: fig. 8, plate I.*

| Multipliers.                             | Areas.    | C. Yds. |
|------------------------------------------|-----------|---------|
| 1. $\frac{30+54}{2} \times 6 =$          | 252       |         |
| 2. $\frac{30+46}{2} \times 4 \times 4 =$ | 608       |         |
| 3. $\frac{30+38}{2} \times 2 =$          | 68        |         |
|                                          | 6) 928    |         |
|                                          | <hr/>     |         |
| $50 \times 154\frac{2}{3} =$             | 171.8     |         |
| By Rule No. 1,                           | $= 177.8$ |         |
| By Rule No. 2,                           | $= 167.0$ |         |

*Example of Case 2: Modification 2: fig. 9, plate II.*

| Multipliers.                          | Areas.    | C. Yds. |
|---------------------------------------|-----------|---------|
| $\frac{30+62}{2} \times 8 =$          | 368       |         |
| $\frac{30+46}{2} \times 4 \times 4 =$ | 608       |         |
| $0 \times 15 =$                       | 0         |         |
|                                       | 6) 976    |         |
|                                       | <hr/>     |         |
| $50 \times 162\frac{2}{3} =$          | 180.7     |         |
| By Rule No. 1                         | $= 204.4$ |         |
| By Rule No. 2,                        | $= 136.3$ |         |

*Example of Case 3: Modification 1: fig. 10, plate II.*

| Multipliers.         | Areas. | C. Yds. |
|----------------------|--------|---------|
| Add.                 |        |         |
| $37 \times 14 = 518$ |        |         |
| $11 \times 10 = 110$ |        |         |
| $18 \times 5 = 90$   |        |         |
| $13 \times 6 = 78$   |        |         |
|                      |        |         |
| Deduct. 796          |        |         |
| $16^2 + 4^2 = 272$   |        |         |
|                      |        |         |
| 524                  | $=$    | 524     |
|                      | <hr/>  |         |
| Carried forward      | 524    |         |



|    |                                           |     |      |
|----|-------------------------------------------|-----|------|
|    | Brought forward                           | 524 |      |
|    | Add.                                      |     |      |
|    | $17.5 \times 10.5 = 183.75$               |     |      |
|    | $15. \times 28.5 = 427.50$                |     |      |
| 2. | $23. \times 6. = 138.$                    |     |      |
|    | $19. \times 5.5 = 104.50$                 |     |      |
|    | $7. \times 14. = 98.$                     |     |      |
|    | <hr/>                                     |     |      |
|    | Deduct. 951.75                            |     |      |
|    | $\overline{18^2} + \overline{5^2} = 349.$ |     |      |
|    | <hr/>                                     |     |      |
|    | Mult. by 4, 602.75                        | =   | 2411 |
|    | Add.                                      |     |      |
|    | $19 \times 21 = 399.$                     |     |      |
|    | $16 \times 20 = 320.$                     |     |      |
| 3. | $12 \times 14 = 168.$                     |     |      |
|    | $10 \times 12 = 120.$                     |     |      |
|    | $8 \times 15 = 120.$                      |     |      |
|    | <hr/>                                     |     |      |
|    | Deduct. 1127.                             |     |      |
|    | $\overline{20^2} + \overline{6^2} = 436.$ |     |      |
|    | <hr/>                                     |     |      |
|    | 691                                       | =   | 691  |
|    |                                           | 6)  | 3626 |

|                |                              |         |
|----------------|------------------------------|---------|
|                | $30 \times 604\frac{1}{3} =$ | 671.5   |
| By Rule No. 1, |                              | = 675.0 |
| By Rule No. 2, |                              | = 672.9 |

Example of Case 3: Modification 2: fig. 11, plate III.

|    | Excavation.                 |        | Embankment.               |        |
|----|-----------------------------|--------|---------------------------|--------|
|    | Multipliers.                | Areas. | Multipliers.              | Areas. |
| 1. | $5 \times 1 = 5$            |        | $16 \times 7 = 112$       |        |
|    | $4 \times 10 = 40$          |        | $6 \times 5 = 30$         |        |
|    | $8 \times 25 = 200$         |        | <hr/>                     |        |
|    | Dedt. 245                   |        | Dedt. 142                 |        |
|    | $\overline{10^2} = 100$     |        | $\overline{8^2} = 64$     |        |
|    | <hr/>                       |        | <hr/>                     |        |
|    | 145                         | = 145  | 78                        | = 78   |
|    | $4.5 \times 1.5 = 6.75$     |        | $11.5 \times 5.5 = 63.25$ |        |
|    | $5. \times 7. = 35.$        |        | $12.5 \times 4. = 50.$    |        |
| 2. | $10.5 \times 17.5 = 183.75$ |        | $10.5 \times 3. = 31.5$   |        |
|    | $13.5 \times 11. = 148.5$   |        | $7.5 \times 3. = 22.5$    |        |
|    | <hr/>                       |        | $14. \times 6. = 84.$     |        |
|    | Dedt. 374.                  |        | $8.5 \times 2.5 = 21.25$  |        |
|    | $\overline{13^2} = 169.$    |        | <hr/>                     |        |
|    | <hr/>                       |        | Dedt. 372.5               |        |
|    | $4 \times 205. = 820$       |        | $\overline{11^2} = 121.$  |        |
|    | <hr/>                       |        | <hr/>                     |        |
|    | Carried over 965            |        | $4 \times 151.5 = 606$    |        |
|    |                             |        | Carried over 684          |        |



3. Brought forward 1364  
 $8 \times 20 = 160$   
 $3 \times 5 = 15$   


---

Dedt. 175  
 $\overline{10^2} = 100$   


---

75 = 75  


---

6)1439

Mean Area =  $239\frac{5}{6}$

Brought forward 655  
 $5 \times 4 = 20$   
 $6 \times 8 = 48$   
 $11 \times 6 = 66$   
 $21 \times 21 = 441$   
 $24 \times 20 = 480$   


---

Dedt. 1055  
 $\overline{20^2} = 400$   


---

655 = 655  


---

6)1310

Mean Area =  $218\frac{1}{3}$

Embankment. C. Yds.  
Mean Area,  $239\frac{5}{6} \times 30 = 266.5$   
By Rule No. 1, = 293.3  
By Rule No. 2, = 263.8

Excavation. C. Yds.  
Mean Area,  $218\frac{1}{3} \times 30 = 242.6$   
By Rule No. 1, = 364.  
By Rule No. 2, = 242.6

Example of Case 3: Modification 4: fig. 13, plate III.

Excavation. Multipliers. Areas.  
1. Excavation = 0  


---

 $2.5 \times 1. = 2.5$   
 $3.5 \times 2.5 = 8.75$   
2.  $5.5 \times 2.5 = 13.75$   
 $9. \times 5. = 45.$   
 $12. \times 2.5 = 30.$   
 $10.5 \times 18. = 189.$   


---

Dedt. 289.  
 $\overline{9^2} = 81.$   


---

 $4 \times 208. = 832$   


---

Carried over 832

Embankment. Multipliers. Areas.  
 $11.5 \times 10 = 115.$   
 $10.5 \times 10 = 105.$   
 $9. \times 4 = 36.$   
 $7.5 \times 10 = 75.$   
 $6.5 \times 5 = 32.5$   
 $6. \times 5 = 30.$   
 $5. \times 5 = 25.$   
 $5. \times 2 = 10.$   


---

Dedt. 428.5  
 $\overline{12^2} = 144.$   


---

284.5  


---

= 284. 5  


---

 $11.5 \times 2. 5 = 28.75$   
 $10.5 \times 2. 5 = 26.25$   
 $9. \times 1. = 9.$   
 $7.5 \times 2. 5 = 18.75$   
 $6.5 \times 1.25 = 8.125$   
 $3. \times 2. 5 = 7.50$   
 $2.5 \times 2. 5 = 6.25$   
 $1. \times 2. 5 = 2.50$   


---

Dedt. 107.125  
 $\overline{6^2} = 36.$   


---

 $4 \times 71.125 = 284. 5$   


---

Carried over 569

| Brought over   |                                    | 832   | Brought over   |                           | 569 |
|----------------|------------------------------------|-------|----------------|---------------------------|-----|
| 3.             | $5 \times 2 = 10$                  |       |                |                           |     |
|                | $7 \times 5 = 35$                  |       |                |                           |     |
|                | $11 \times 5 = 55$                 |       |                |                           |     |
|                | $18 \times 10 = 180$               |       |                |                           |     |
|                | $24 \times 5 = 120$                |       |                |                           |     |
|                | $21 \times 36 = 756$               |       |                |                           |     |
|                | <hr/>                              |       |                |                           |     |
|                | Dedt. 1156                         |       |                |                           |     |
|                | $18^2 = 324$                       |       |                |                           |     |
|                | <hr/>                              |       |                |                           |     |
|                | 832                                | = 832 |                |                           |     |
|                | <hr/>                              |       |                |                           |     |
|                | 6) 1664                            |       |                |                           |     |
|                | <hr/>                              |       |                |                           |     |
|                | Mean Area = $277\frac{1}{3}$       |       |                |                           |     |
| Excavation.    | C. Yds.                            |       | Embankment.    | C. Yds.                   |     |
| Mean Area,     | $277\frac{1}{3} \times 30 = 308.1$ |       | Mean Area,     | $94.83 \times 30 = 105.4$ |     |
| By Rule No. 1, | = 462.2                            |       | By Rule No. 1, | = 158.                    |     |
| By Rule No. 2, | = 308.1                            |       | By Rule No. 2, | = 105.4                   |     |

Objections may possibly be urged against the hypothetical generation of intermediate ground by means of middle sections, and it is difficult to free this subject wholly from exception; but with a given number of transverse sections taken in the field, if close attention is paid to the inclination of the ground as developed by the end sections, and occasionally where it is very complex, if the figures are simplified by introducing additive or deductive solids, we have not yet met with any other practical method, giving results equally satisfactory.

Various expedients are known to engineers for facilitating the computation of the areas of cross sections, to attempt an account of which, though it might be interesting to students, would prolong this paper to an inconvenient length.

The above examples embrace, as we have stated, specimens of the principal varieties of excavation and embankment; and a little attention to the calculations and the modes of deducing the middle sections between those usually taken in the field, will enable any one to apply the "Prismoidal Process" to the mensuration of earth work upon canals, roads or railroads. When the mean areas are computed, it will be much more expeditious to get out the cubic yards from a table of cubic yards previously made out (supposing the stations regularly 100 feet,) for each foot and tenth of mean area, from 0.1 up to the largest which commonly occur: such or similar tables in manuscript are in the possession of many engineers, but those who have them not can in a few days construct a set by simple addition, and verify them by observing how the cubic yards for the preliminary areas of the first hundred, are subsequently repeated in the same decimal place.

Indeed, Mr. Macneill's tables (if extended to tenths of feet) might be used; by constructing a supplemental set to show by inspection the height or centre cutting in level ground, of two sections with the given base and slopes, to be respectively equivalent in area, to the end sections of any given length of excavation or embankment; or these heights could be ascertained by the aid of an ingenious formula given by Mr. Macneill, and being found might then be wrought with in entering the tables according to the directions laid down: either of these proceedings, by determining a true mean cut-



Fig. 1.

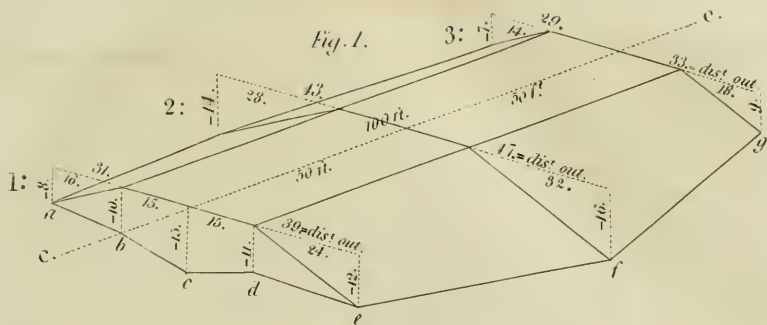


Fig. 2.

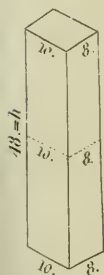


Fig. 3.



Fig. 4.

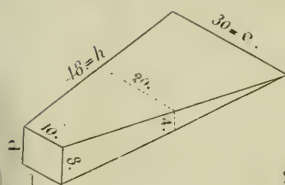


Fig. 5.

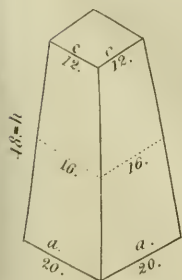


Fig. 6.

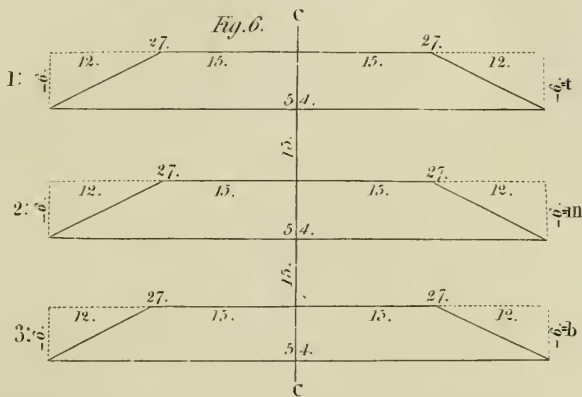


Fig. 7.

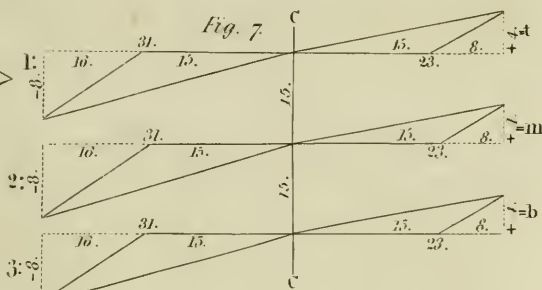


Fig. 8.

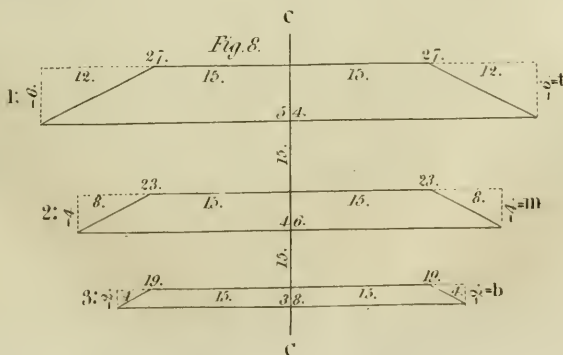






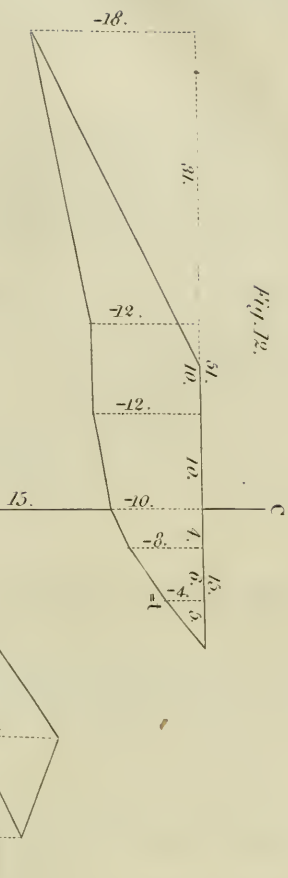




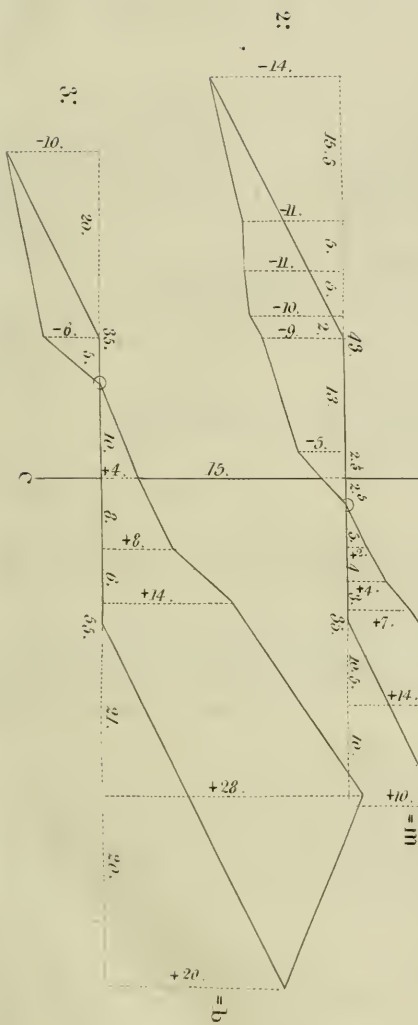




Fig. 12.



1:







ting at each end, would obviate the necessity of a middle section, but neither, it is believed, would be altogether as satisfactory.

We desire to be understood as suggesting the application of the preceding process only to those exact calculations, required by the *Final Estimates* of sections; for running estimates or those on lines of location, less accurate but more speedy methods will answer every purpose.

Oldtown, Md., November 20th, 1839.

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

In the Railway Magazine, (London,) for August, 1839, I observed a formula for calculating the area of a cross section of excavation in, or embankment on, sloping ground. I shall feel indebted to any of your correspondents who will furnish me with a solution by which its correctness may be ascertained.

Having the bottom width given, if excavation, (or top width, if embankment,) =  $E$ ; the depth at  $\frac{E}{2}$  from the centre, on each side, =  $D$  and  $d$  respectively; and the ratio of the side slopes =  $r$ ; the following is the formula given,

$$\frac{E r d^2}{2E + 2r (D - d)} + \frac{E r D^2}{2E - 2r (D - d)} + \frac{E (D + d)}{2} = \text{area.}$$

Respectfully, &c.

J. M. H.

Philadelphia, Jan. 1, 1840.

*Telford Premiums to be awarded by the Institution of Civil Engineers of London.\**

The Committee on Publications of the Franklin Institute having received the following circular from the Institution of Civil Engineers, lay it with pleasure before the readers of the Journal, believing, that to many of them it will be a subject of interest.

COM. PUBLICATIONS.

*Institution of Civil Engineers, established 1818, incorporated 1828.*

The Council of the Institution of Civil Engineers give notice that they will award, during the ensuing session, Telford Premiums to Communications of adequate merit on the following subjects:

1. The nature and properties of steam, especially with reference to the quantity of water in a given bulk of steam in free communication with water at different temperatures.

2. An account and drawings of the original construction and present state of the Plymouth breakwater.

3. The ratio, from actual experiment, of the velocity, load, and power, of locomotive engines on railways.

1st. Upon levels.

2nd. Upon inclined planes.

4. Drawings and description of the outfall of the King's scholars' pond sewer, and of other principal outfalls of the Westminster sewer; also, the

\*The premiums of this Institution are awarded to Foreigners as well as Englishmen.

inclination, dimensions, and forms, of the sewers, and the observed velocities of water in them.

5. Drawings and descriptions of the sewage under the commission for Regent street, especially of the outfall at Scotland yard.

6. Drawings and description of the best machine for describing the profile of a road, and also for measuring the traction of different roads.

7. The alterations and improvements in Blackfriar's bridge.

8. The explosion of steam boilers.—Especially a record of facts connected with any explosions which have taken place; also, a description, drawings, and details, of the boiler, both before and after the explosion.

9. Drawings, sections, and descriptions, of iron steam vessels.

10. The comparative advantages of iron and wood as employed in the construction of steam vessels.

11. The comparative advantages and disadvantages of hot and cold blast in the manufacture of iron, with statements of the quality and quantity of materials employed, and produce thereof.

12. The causes of, and means of preventing, the changes in texture and composition which cast iron occasionally undergoes when in continued contact with sea water.

13. The properties and chemical constitution of the various kinds of coal.

14. A memoir of Sir Hugh Middleton, with an account of his works.

15. A memoir of Arthur Woolf, with an account of his works.

16. An account of the various methods lately employed for preserving timber from dry rot, and other sources of decay.

17. On the best gauge for the width of railways, with the result of the experience furnished by existing railways.

The communications must be forwarded to the House of the Institution, No. 25, Great George street, Westminster, on or before the 31st of March, 1840.

It is not the wish of the Council to confine the Telford Premiums to communications on the above subjects; other communications of distinguished merit and peculiarly deserving some mark of distinction will be rewarded.

Copies of this paper, and any farther information, may be obtained on application to the Secretaries.

THOMAS WEBSTER, } Secretaries.  
CHARLES MANEY, }

25, Great George street, Westminster, June 25, 1839.

### *Telford Premiums.*

The Council of the Institution of Civil Engineers have awarded the following Telford Premiums:—

A Telford medal in silver and twenty guineas to John Edward Jones, for his description, plan and drawings of the sewage of Westminster.

A Telford medal in silver to Charles Hood, for his paper on warming and ventilating buildings.

A Telford medal in silver to Charles Wye Williams, for his paper on the properties and application of turf and turf coke.

A Telford medal in silver to Edward Woods, for his paper on the forms of locomotive engines.

A Telford medal in bronze, and books suitably bound and inscribed, of the value of three guineas, to Lieut. Frederick Pollock, Madras Engineers, for his description and drawings of the Coffre Dam of Westminster bridge.

A Telford medal in bronze, and books suitably bound and inscribed, of the value of three guineas, to R. W. Mylne, for his communication on the well sunk by the New River Company at their reservoir in the Hampstead Road.

A Telford medal in bronze, and books suitably bound and inscribed, of the value of three guineas, to John Buldry Redman, for his description and drawings of Bow bridge.

The Council would take this opportunity of calling attention to the importance of making the Institution the depository of detailed drawings, descriptions, and models, of works and machinery actually executed; also of professional books, papers, and reports, which are of little value to the individual, but which, when collected and arranged in one place, would be of inestimable value to the profession. They trust that all who have such records at their disposal will consider the great service which may thus be rendered to the cause of the advancement of professional knowledge.

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### **Bibliographical Notices.**

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*Report on Education in Europe, to the Trustees of the Girard College for Orphans; by ALEX. DALLAS BACHE, L. L. D., President of the College.*

It is probably known to most of the readers of this Journal, that soon after the appointment of Professor Bache to the Presidency of the Girard College, he was deputed by the Trustees to visit those parts of Europe in which it was known that education had made the greatest progress, for the purpose not only of making the system of instruction therein pursued, better known to his countrymen, but especially that he might have more abundant materials and a broader foundation for a plan of education for the magnificent Institution over which he is to preside. He was engaged about two years in his visitations and inquiries, and no reader, we are persuaded, will venture to say, that his time was not most industriously and judiciously occupied. We have read the report with the deepest interest—albeit an octavo volume of 666 pages,—and we make the unqualified acknowledgment that in our estimation Dr. B. has performed the task assigned him, thus far, with sound discrimination, and in the exercise of a judgment and good taste which will redound to his credit on both sides of the Atlantic.

It was necessary in such an expansive survey of the educational institutions of different nations, to classify the objects of his investigation; not only to consider education in its threefold relation to the physical, the intellectual, and the moral nature of man, but to regard it in its aptitudes to the different classes into which human society is, in every civilized country, inevitably arranged, by age and condition in life. The importance of such a distinction was at once perceived by the author, and instead of giving a geographical detail of the schools and systems which he examined, he first describes the institutions for the education of orphans and destitute children in England, Scotland, Germany, Prussia and Holland; then the schools for infant instruction—primary or elementary schools in France, England, and other countries—schools of agriculture and industry—seminaries for the preparation of teachers, including the normal schools of France—secondary schools; and finally, superior schools, embracing all that is most worthy of notice under each of these heads in the different countries which he visited.



The report is indeed voluminous, but we could not easily point to the chapter, or even the page, that could well have been spared, considering that the task was assigned him of making a faithful exhibition of the most important institutions of Europe. We rather indeed regret that its needful limitations precluded the author from reporting upon the Universities of Great Britain and Ireland, and the older Institutions of the Continent, appropriated to the higher grades of classical literature and science.

“They had their origin (says the author) in the wants of an early period of civilization, and have continued to be as necessary in its progress, requiring great changes, however, to enable them to keep pace with the times. Schools of arts, or polytechnic schools, have originated in the requirements of modern times, in which occupations have risen in standing and importance, or have been actually created, by the progress of science and the arts. Considered as special schools, the universities have very different objects from those which the founder of the Girard College intended as the aim of his institution, while the purposes of the polytechnic schools are strictly in accordance with those which his will points out for the highest department of his college. This being the case, a description of foreign universities would, I conceive, be out of its place in this Report. From the character of my associations, before leaving home, which naturally led to similar associations while abroad, I felt highly interested in this class of institutions, and it is with reluctance I have come to the conclusion not to give some description of them in my Report. While it is exceedingly difficult to judge of the results of university systems of different countries, especially so from the amount of talent arrayed in favour of, and even positively against, different systems, and I should make no pretensions to offer such a judgment, the institutions are by no means difficult to describe, so that a reader may conceive the form of the system, and endow that form with spirit, in proportion to the force of his own natural powers, and his experience. The differences between the university systems of Great Britain, France, and Germany, afford interesting subjects of reflection to those whose pursuits and dispositions lead them to efforts for the improvement of ‘superior education.’ Considering these different systems as so many experiments made under different circumstances, the study of their results, and the modifying effect of circumstances, is no less interesting than useful. The field is, however, vast; the varieties in Great Britain alone would require much space for due description, as a few words will suffice to show. The Scotch and English universities differ very much in their organization, discipline, and instruction, and even the several Scotch universities are not alike. At Glasgow, and the academical institution at Belfast, founded upon its model, the pupils enter, in general, in very early youth. The lectures are, therefore, mixed with recitations held by the professors, which, however, the large classes at Glasgow prevent from being efficacious. The students do not reside in either of these institutions. At Edinburgh, the average age of the student is greater, and the medical department assumes, relatively to that of letters, an importance which modifies the character of the school. The lesser universities of St. Andrews and Aberdeen differ more from the others in the arrangement of discipline, resulting from the residence of a part of the students in the colleges composing them, than in the character of the instruction. In the larger English universities of Cambridge and Oxford, composed of colleges and halls, in the buildings of which the students generally reside, the discipline of each college may be said to be its own, with a



general conformity to that of the university.\* The same is true in regard to the instruction, with this difference, that as all the courses tend towards the preparation for university degrees and university honours, there is a general conformity in the several colleges in the subjects taught and methods of teaching. The instruction given by the tutors in the colleges is upon the same general plan, a mixture of lecture and recitation, and, as the attendance upon the lectures of the university professors is not obligatory, forms the real basis of the intellectual part of the university education. The inducements held out to exertion in these schools by the rewards which the fellowships and the stations to which they may lead hold forth, and which bring into them the greater part of the best talent of England, produce results which are of the highest order, but which cannot fairly be considered as depending mainly upon the system of instruction and discipline. It must require a very accurate knowledge of facts, with an entire absence of prejudice, to reason as to the general results of the various parts of the complex system, which has grown with the growth of these institutions themselves, and is, therefore, now very deeply rooted.

"I consider the opportunity which I enjoyed of witnessing some of the written examinations at Cambridge as of the highest value, and am no longer surprised at the attachment to this method which is there felt. It is accurate and expeditious in its results, removes all possibility of, or temptation to, show, and even the suspicion of partiality, in the distribution of important places. While I am not yet persuaded that it can supersede the viva voce method, or be employed to such an extent as to sink the use of the latter into comparative insignificance, yet, if the choice lay between the use of the one or other method extensively, I should now prefer the former.

"At the university of Dublin (Trinity College,) the advantages of the tutorial system are combined with that of the lectures by professors, which the students are enjoined to attend, and the same is the case at the recently erected university of Durham. This university has set the example of adding instruction in civil engineering to its literary courses, and has admitted the modern languages into the latter. King's College and London University College have hardly yet taken the form which time must impress upon them in their new connexion with the London University; the enactments of this recent corporation, in regard to the requirements for degrees, must ultimately regulate the higher studies of these and other institutions, presenting candidates for them. This bare enumeration will serve to show, that to give any thing like an idea of institutions so various in their character, would require much time and more space than could properly be bestowed in a report, to the purpose of which the greater part of the particulars would be found inappropriate. No doubt useful hints might be gathered, but by far the greater part of the matter would be entirely inapplicable to our purpose. For example, the system of university degrees, by which encouragement is given to general effort, and of the privilege to teach, or of stations without actual duty, by which, in many establishments, individual exertion is stimulated and rewarded, are entirely inapplicable to the circumstances of our institution. Again; the tone and modes of discipline, both in those institutions where the pupils reside and in those where they merely come at stated times to receive instruction, are inapplicable to our case, and the general organization and government are not less so. Fur-

\* A very accurate account of the universities of Cambridge and Oxford is to be found in the report to the Board of Trustees of the University of Pennsylvania, by Philip H. Nicklin, Esq., one of its members.

ther, the instruction, as far as it is of a special character, qualifying for admission to the learned professions, as in the continental system, has, of course, no bearing upon our arrangements, and leaves for profitable study the subjects of at most two faculties. In these the titles of the branches themselves would be all that could serve us; for the mode of lecturing being universally adopted, the treatment of the subject depends upon the individual professor."

We hope that the author may be induced, at some future time, to furnish, either in a supplementary report, or in some other form, the result of his visits to the universities. A detail of their organizations, various and dissimilar as they are, and complicated as some of them, by long usage, have become, would be highly interesting to the scholars of this country.

However disposed some of the readers of this volume may be to complain of repetition in the statistical accounts of institutions, similar in their objects, we do not see how the reporter could have omitted any of his tabular illustrations, or individual statements, without furnishing grounds of complaint to those who will look to his volume for a specific statement of each, or any, of the prominent institutions relative to which they may wish information. It is by a minute comparison of means and results that we arrive at the most valuable truths in practical science; and certain it is that in the great science of education there is still much to be learnt, and to no people is this knowledge more important than to the inhabitants of our republic.

The state of popular education in the different parts of our extended territory is perhaps as various as in the different countries of Europe visited by Dr. Bache. However we may be disposed to congratulate ourselves on the provision made in most of the States for supporting schools, a strict examination would, we fear, demonstrate in many parts of our country, as great a destitution of all literary instruction as could be found in almost any part of Europe. In particular sections of the United States the most laudable efforts are unquestionably in operation to elevate the standard of common schools and academies to the highest point of philanthropic ambition; but whoever reads attentively the volume before us must make the acknowledgment, however painful to his *amor patriæ*, that in no part of our favoured land is the science of education fully understood, and its precepts carried into practical operation. The main reason is that little or nothing has been done to educate those who are to become the educators of the people. The means have not been provided for opening the arena of competition for the display of genius and talent in the highest of all practical arts—the discovery of the most efficient means of evolving the powers of the mind in connexion with the virtuous energies of the heart and affections. Until the business of the educator is raised to a rank correspondent in respectability with any other professional pursuit, it is not to be imagined that skill will be shown in the management of schools to a degree which the wants and faculties of the man, while "yet in the gristle," absolutely require.

This subject we know is beginning to claim attention in several of the States, and we regard it as the earnest of a spirit of higher importance to the welfare of the country, than any thing within the whole range of politics, trade, or other matters relating to mere physical improvement. It is in this point of view especially, that we could wish the Report of President Bache placed in the hands of every teacher and manager of schools throughout the country. It will show them at what an unimagined distance we are still behind, in spirit and advancement, the educational institutions of

some parts of Europe; and yet with what an accelerated motion, with the means and appliances in our possession, we may follow on in the track of a noble rivalry, and the acquirement of a distinction as flattering to the moral strength of the nation as its ships, factories, and rail roads are to its intellectual and physical energies.

As an example, appropriate to the pages of our journal, of the style and descriptive talent of the Reporter, so long an efficient *colaborateur* in the concerns of the Franklin Institute, we quote his account of the "School of Arts of Berlin."

*Institute of Arts of Berlin.\**

"This institution is intended to impart the theoretical knowledge essential to improvement in the arts, and such practical knowledge as can be acquired to advantage in a school. It is supported by the government, and has also a legacy, to be expended in bursaries at the school, from Baron Von Seydlitz. The institution is under the charge of a director,† who has the entire control of the funds, of the admissions and dismissions, and the superintendence of the instruction. The professors and pupils do not reside in the establishment, so that the superintendence is confined to study-hours. There are assistant professors, who prepare the lectures, and conduct a part of the exercises, in some cases reviewing the lessons of the professors with the pupils. Besides these officers there are others, who have charge of the admirable collections of the institution, and of the work-shops, offices, &c. The number of professors is eight, and of repeaters, two. The discipline is of the most simple character, for no pupil is allowed to remain in connexion with the institution unless his conduct and progress are satisfactory. There is but one punishment recognised, namely, dismissal; and even a want of punctuality is visited thus severely.

"In the spring of every year the regencies advertise that applications will be received for admission into the institute, and the testimonials of the candidates who present the best claims are forwarded to the director at Berlin, who decides finally upon the several nominations. The pupils from the provincial schools have, in general, the preference over other applicants. At the same time notice is given by the president of the Society for the Promotion of National Industry, in relation to the bursaries vacant upon the Seydlitz foundation. The qualifications essential to admission are—to read and write the German language with correctness and facility, and to be thoroughly acquainted with arithmetic in all its branches. The candidate must, besides, be at least seventeen years of age. Certain of the pupils, as will be hereafter more fully stated, require to have served an apprenticeship to a trade. The Seydlitz bursars must, in addition, show—1st. That their parents were not artisans,‡ relatives of the founder having the pre-

\* *Gewerbinstitut*, literally, trade institute. I am indebted to the director, privy counsellor Beuth, for a lithographic outline and programme of this institution, and to the Hon. Henry Wheaton, minister of the United States at Berlin, for an account of the industrial schools of Prussia, by Captain Beaulieu, Belgian *chargé d'affaires* at Berlin. M. Beuth gave me every facility in visiting the institution.

† The director, M. Beuth, is also president of the Royal Technical Commission of Prussia, and has the distribution of the funds for the encouragement of industry, amounting to about seventy-five thousand dollars annually. M. Beuth is also a privy counsellor, and is president of the Society for the Encouragement of National Industry in Prussia.

‡ The object of M. Von Seydlitz appears to have been to counteract, to the extent of his power, the tendency to the increase of the learned professions, at the expense of the mechanic arts, by an inducement to a course exactly contrary to the usual one.



ference over other applicants. 2d. That they have been apprenticed to a trade, if they intend to follow one not taught in the institution. 3d. They must enter into an engagement that if they leave the mechanical career they will pay back the amount of their bursaries. There are sixty or seventy gratuitous pupils in the school, of whom eighteen are upon the Seydlitz foundation. Forty are admitted annually, this number having been adopted because it is found that, in the course of the first month, about a fourth of the newly admitted pupils fall away from the institution. Each bursar receives two hundred and twenty-five dollars per annum for maintenance. The education is gratuitous. The regular pupils enter on the first of October; but the director is authorized to admit, at his pleasure, applicants who do not desire to become bursars, but who support themselves, receiving gratuitously, however, the instruction afforded by the institution.

"The education of the pupils is either solely theoretical, or combines theory and practice, according to the calling which they intend to follow. The first division is composed of students, who receive theoretical instruction only, and who are preparing to become masons, carpenters, and joiners. They are supposed to have become acquainted with the practice of their trade before entering the institution, being required to have served, previously, a part of their apprenticeship. An excellent reason is assigned for this rule, namely, that on leaving the school such pupils are too old to begin their apprenticeship to these callings, and would, if they attempted to do so, find the first beginnings so irksome as to induce them to seek other employments, and thus their special education would be lost, and the object of the school defeated. The second division embraces both theoretical and practical instruction, and consists of three classes. First, the stone-cutters, engravers, lapidaries, glass-cutters, carvers in wood and ivory, and brass-founders. Second, dyers and manufacturers of chemical products. Third, machine-makers and mechanicians. The practical instruction is different for each of these three classes.

"The general course of studies lasts two years, and the pupils are divided into two corresponding classes. The first class is, besides, subdivided into two sections. The lower, or second, class is taught first; mechanical drawing, subdivided into decorative drawing, including designs for architectural ornaments, utensils, vases, patterns for weaving, &c., and linear drawing, applied to civil works, to handicrafts, and to machines. Second, modeling in clay, plaster, and wax. Third, practical arithmetic. Fourth, geometry. Fifth, natural philosophy. Sixth, chemistry. Seventh, technology, or a knowledge of the materials, processes, and products of the arts. The studies of the lower section of the first class are general, while those of the first section turn more particularly upon the applications of science to the arts. In the lower section, the drawing, modeling, natural philosophy, and chemistry, of the first year, are continued; and, in addition, descriptive geometry, trigonometry, stereometry, mixed mathematics, mineralogy, and the art of construction, are studied. In the upper or first section, perspective, stone-cutting, carpentry, and mechanics applied to the arts, are taught, and the making of plans and estimates for buildings, work-shops, manufactories, machines, &c. These courses are common to all pupils, whatever may be their future destination; but beside them, the machinists study, during the latter part of their stay at the institution, a continuation of the course of mechanics and mathematical analysis. The examples accompanying the instruction in regard to plans and estimates are adapted to the intended pursuits of the pupils.



"The courses of practice are begun by the pupils already enumerated as taking part in them, at different periods of their stay in the institution. The future chemists and mechanics must have completed the whole range of studies above mentioned, as common to all the pupils, while the others begin their practice after having completed the first year's course. There are work-shops for each class of pupils, where they are taught the practice of their proposed calling, under competent workmen. There are two foundries for bronze castings, one for small, the other for large castings, and the work turned out of both bears a high character. A specimen of this work is retained by the institution in a beautiful fountain, which ornaments one of the courts of the building. The models for castings are made in the establishment. In the first division of pupils, in reference to their callings, there are usually some whose art is connected with the fine arts in some of its branches, and these have an opportunity during part of the week to attend the courses of the Berlin Academy. The future chemists work for half the year in the laboratory. They are chiefly employed in chemical analysis, being furnished with the requisite materials for practice by the institution. In the shops for the instruction of mechanics are machines, for working in wood and the metals, a steam-engine of four horses' power, a forge, tools in great variety, lathes, &c. The pupils have the use of all necessary implements, according to their progress, and are gradually taught as if serving a regular apprenticeship. When capable, they are enabled to construct machines which may be useful to them subsequently, as a lathe, or machine for cutting screws, or the teeth of wheels, &c., and are furnished with all the materials for the purpose, the machine becoming their own property. In these work-shops, also, the models for the cabinet of the school are made. This is by far the most complete establishment for practice which I met with in any institution, and I believe the practice is both real and effectual. It involves, however, an expenditure which in other cases it has not been practicable to command. The scale of the whole institution is, in the particular of expenditure, most generous.

"This is one specimen of the various plans which have been devised to give practical knowledge of an art in connexion with theory in a school. It is first most judiciously laid down that certain trades cannot be taught to advantage in a similar connexion, but that the practical knowledge must be acquired by an apprenticeship antecedent to the theoretical studies. There are besides, however, a large number of trades, the practice of which is to be taught in the institution, and requiring a very considerable expenditure to carry out the design properly. This could not be attempted in a school less munificently endowed, and requires very strict regulations to carry it through even here. The habits of a school work-shop are, in general, not those of a real manufactory, where the same articles are made to be sold as a source of profit; hence, though the practical knowledge may be acquired, the habits of work are not, and the mechanic may be well taught but not well trained. At the private school of Charonne, work-shops were established, giving a variety of occupation to the pupils; but the disposition to play rather than to work, rendered these establishments too costly to be supported by a private institution, and the plan adopted instead of this, was to make the pupils enter a regular work-shop for a stated number of hours, to work for the proprietor or lessee. This plan remedies one evil, but introduces another, that as the machinist takes orders, with a view to profit, the work may have so little variety as only to benefit a small class of the pupils. The pupils at Charonne are, however, under different circum-

stances from those at Berlin; they are generally younger, and, being independent of the school, where they pay for their education, are not under the same restraint as in the other institution; hence the experience of the one school does not apply in full force to the other. At Dresden, in a school somewhat similar to that of Berlin, a different mode from either of those just mentioned has been adopted. An arrangement is made with a number of mechanics, of different occupations, to receive pupils from the schools as apprentices, allowing them the privilege of attending, during certain specified hours of the day, upon the theoretical exercises of the institution. Where such an arrangement can be made, the results are unexceptionable, and the advantages likely to accrue to the mechanic arts, from the union of theory with practice, will offer a strong inducement to liberally disposed mechanics to take apprentices upon these terms. Small workshops, connected with an institution, must necessarily offer inferior advantages, even if closely regulated, so as to procure the greatest possible amount of work from the pupils; this should not be done for the sake of the profit, but to give him genuinely good habits.

"The difficulties in giving practical instruction in the chemical arts are not to be compared with those under discussion, and will be found to have been satisfactorily obviated in several schools. This subject will receive its more appropriate discussion in connexion with the polytechnic institution of Vienna, where the chemical department, at least as far as manufacturing chemistry is concerned, is generally recognised as having produced the best results of any yet established.

"Returning to the subject of the theoretical instruction in the Berlin institute of arts, the following statement will serve to show the succession of the courses, with the time devoted to each:—

#### *Winter Course.*

**MONDAY.—First Class.** First division—drawing and sketching machines, eight A. M. to twelve o'clock. Discussion of machines, estimates of power, &c., two P. M. to five P. M. Second division—machine drawing, eight to ten. Modeling in clay, ten to twelve. Physics, two to five. *Second Class.* Machine-drawing, eight to ten. Modeling, ten to twelve. Elements of geometry, two to four. Repetition of the lecture, four to five.

**TUESDAY.—First Class.** First division—architectural plans and estimates, eight to twelve. Practical instruction in machinery, two to five. Second division—ornamental and architectural drawing, eight to twelve. Trigonometry, two to five. *Second Class.* Ornamental and architectural drawing, eight to twelve. Physics, two to four. Repetition of the lecture, four to five.

**WEDNESDAY.—First Class.** First division—original designs, eight to twelve. Discussion of machinery. Second division—mineralogy, eight to nine. Machine-drawing, nine to twelve. Trigonometry, two to five. *Second Class.* Machine-drawing, eight to twelve. Practical arithmetic, two to five.

**THURSDAY.—First Class.** First division—Drawing and sketching machines, eight to twelve. Architectural instruction, estimates, two to five. Second division—decorative and architectural drawing, eight to ten. Modeling in clay, ten to twelve. Trigonometry, two to five. *Second Class.* Decorative and architectural drawing, eight to ten. Modeling in clay, ten to twelve. Physics, two to four. Repetition of the lecture, four to five.

**FRIDAY.—First Class.** First division—architectural plans, eight to twelve.

Practical instruction in machinery, two to five. Second division—machine-drawing, eight to twelve. Physics, two to five. *Second Class.* Machine-drawing, eight to twelve. Elementary mathematics, two to four. Repetition of the lesson, four to five.

**SATURDAY.**—*First Class.* First division—perspective and stone-cutting, eight to twelve. Original designs, two to five. Second division—mineralogy, eight to nine. Decorative and architectural drawing, nine to twelve. Trigonometry, two to five. *Second Class.* Decorative and architectural drawing, eight to twelve. Practical arithmetic, two to five.

The summer term, which follows this, embraces the practical instruction.

*Summer Term.*

**MONDAY.**—*First Class.* First division—in the work-shops from seven A. M. to twelve, and from one until seven P. M. Second division—machine-drawing, eight to twelve. Applied mathematics, two to five. *Second Class.* Machine-drawing, eight to ten. Modeling, ten to twelve. Chemistry, two to four. Repetition, four to five.

**TUESDAY.**—*First Class.* First division—analytical dynamics, eight to nine. Drawing of machines from original designs, nine to twelve. Machinery, two to five. Second division—decorative and architectural drawing, eight to twelve. Chemistry, two to five. *Second Class.* Decorative and architectural drawing, eight to twelve. Elementary mathematics, two to four. Repetition, four to five.

**WEDNESDAY.**—*First Class.* First division—in the work-shops from seven to twelve, and from one to seven. Second division—machine-drawing, eight to ten. Modeling, ten to twelve. Applied mathematics, two to five. *Second Class.* Machine-drawing, eight to twelve. Practical arithmetic, two to four. Materials used in the arts, four to five.

**THURSDAY.**—*First Class.* First division—in the work-shops from seven to twelve, and from one to seven. Second division—machine-drawing, eight to ten. Modeling, ten to twelve. Applied mathematics, two to five. *Second Class.* Decorative and architectural drawing, eight to ten. Modeling, ten to twelve. Chemistry, two to four. Repetition of the lesson, four to five.

**FRIDAY.**—*First Class.* First division—analytical dynamics, eight to nine. Drawing of a machine for an original design, nine to twelve. Machinery, two to five. Second division—chemistry, eight to nine. Applied mathematics, nine to twelve. Chemistry, two to five. *Second Class.* Machine-drawing, eight to twelve. Elementary mathematics, two to four. Repetition of the lesson, four to five.

**SATURDAY.**—*First Class.* First division—in the work-shops from seven to twelve, and from one to seven. Second division—decorative and architectural drawing, eight to twelve. Applied mathematics, two to five. *Second Class.* Decorative and architectural drawing, eight to twelve. Practical arithmetic, two to four. Materials used in the arts, four to five.

The chemical division of the practical classes is engaged every day in the laboratory. On Tuesday and Wednesday the library is open for reading from five to eight, P. M.

“The collections for carrying out the various branches of instruction are upon the same liberal scale with the other parts of the institution. There is a library of works on architecture, mechanics, technology, the various arts, archeology, &c., in German, French and English. This library is open



twice a week, from five to eight in the evening, to the pupils of the first class of the school, and to such mechanics as apply for the use of it.

"There is a rich collection of drawings of new and useful machines, and of illustrations of the different courses, belonging to the institution. Among them is a splendid work, published under the direction of Mr. Beuth, entitled *Models for Manufacturers and Artisans* (*Vorlegeblätter für Fabricanten und Handwerker*), containing engravings by the best artists of Germany, and some even from France and England, applicable to the different arts and to architecture and engineering. Among the drawings are many from original designs by Shenckel, of Berlin.\* There is a second useful but more ordinary series of engravings, on similar subjects, also executed for the use of the school. These works are distributed to the provincial trade schools, and presented to such of the mechanics of Prussia as have especially distinguished themselves in their vocations. The collection of models of machinery belonging to the school probably ranks next in extent and value to that at the Conservatory of Arts of Paris. It contains models of such machines as are not readily comprehended by drawings. Most of them are working models, and many were made in the work-shops of the school. They are constructed, as far as possible, to a uniform scale, and the parts of the models are of the same materials as in the actual machine. There is an extensive collection of casts, consisting of copies of statues, basso-relievos, utensils, bronzes, and vases of the museums of Naples, Rome, and Florence, and of the British Museum, and of the models of architectural monuments of Greece, Rome, Pompeii, &c., and copies of models, cameos, and similar objects; those specimens only have been selected which are not in the collection of the Academy of Fine Arts of Berlin, to which the pupils of the Institute of Arts have access. There are good collections of physical and chemical apparatus, of minerals, of geological and technological specimens.

"The instruction is afforded in part by the lectures of the professors, aided by text-books specially intended for the school, and in part by the interrogations of the professors and of the assistants and repeaters. At the close of the first year there is an examination to determine which of the pupils shall be permitted to go forward, and at the close of the second year to determine which shall receive the certificate of the institute. Although the pupils who come from the provinces are admitted to the first class of the institute, upon their presenting a testimonial that they have gone through the courses of the provincial schools satisfactorily, it frequently happens that they are obliged to retire to the second, especially from defective knowledge of chemistry.

"The cost of this school to the government is about twelve thousand dollars annually, exclusive of the amount expended upon the practical courses and upon the collections—a very trifling sum, if the good which it is calculated to do throughout the country is considered. The comparatively recent existence of the institution does not admit of appealing to decided results which have flowed to the mechanic arts in Prussia from its establishment, but there can be no doubt of its tendency, and its pupils are already known to be making their way successfully, in consequence of the advantages which they have here enjoyed."

We trust, it will not be very long before the institution of seminaries, analogous in principle to the one above described, will become an object of

\* A copy of this work has been most liberally presented to the Girard College by the Technical Commission, of which, Mr. Beuth is president. The work having been published by the government, is not sold.



legislative regard in some, at least, of the United States. Schools for the blind, and for deaf mutes, have taken root effectually in the philanthropy of the country, and it is scarcely to be questioned that the tendency of our civism is to the adoption of every useful discovery, whether in mechanical or moral science, as soon as its character of utility and beneficence has received the sanction of an evident demonstration.

G.

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*Scientific Memoirs, selected from the transactions of Foreign Academies of Science, and learned Societies, and from Foreign Journals. Edited by*  
RICHARD TAYLOR, F. S. A.

The enterprise of the Editor of this valuable series of papers we can readily conceive to have been dictated by the pure love of Science, and the pleasure derived from witnessing its extensive and increasing propagation in every country where the English language is read and spoken. Without some such undertaking, many of the most learned and original papers, published in Russia, Prussia, Germany, France, and Italy, would remain excluded from English readers, excepting the few who could gain access to the foreign Journals, and were able to relish their perusal in a foreign tongue.

The Editor, after being encouraged to commence the translation and publication of the best of the foreign memoirs, a work which necessarily involved no little expense, was obliged, on the completion of the first volume to suspend it for some time for want of adequate patronage. We are pleased to find that this result has excited a feeling of regret among the friends of Science in Great Britain, and that the Editor is again encouraged to persevere. Part 2d, of the 2d vol., (part 6th, of the whole) has just been received by the Franklin Institute, and we can do no less than speak in terms of high commendation of the beauty of the paper, and of the execution, typographical and lithographical.

The contents of part VI, are,

1. Memoir on the Polarization of Heat. By Macedoine Melloni.
2. General Theory of Terrestrial Magnetism. By Carl Friedrich Gauss, Professor in the University of Gottingen.
3. On a new Instrument for the direct Observation of the changes in the intensity of the horizontal portion of the terrestrial magnetic force. By Carl Friedrich Gauss.
4. Observations on the arrangement and use of the Bifilar Magnetometer. By Wilhelm Weber.
5. Contributions to our knowledge of Phytogenesis. By Dr. M. J. Schleiden.

The names of the authors of these memoirs are sufficient to impress the stamp of high value on the contents of part VI., and although the essays may be too learned for popular perusal, they ought to be accessible to teachers and professors of Science, and hence, are deserving a place in every College Library, and collection of learned works on Science. In the subscription list we find but five copies for the United States, and those all in Philadelphia except one, viz: Columbia College, New York.

G.

## Physical Science.

NASHVILLE UNIVERSITY, Jan. 1, 1840.

TO THE COMMITTEE OF THE FRANKLIN INSTITUTE ON METEOROLOGY.

GENTLEMEN,—Believing that your committee on Meteorology would gladly receive a few observations during the late solstice, I send you my notes of the weather at that time. I begin with Dec. 21st, and continue them with some intermissions to the 24th. If you think them worthy, you may send them in such form as you think fit, to the South African L. & Phil. Institution. The remainder of my communication is intended for your Committee.

The past summer exceeded in drought, not only that of 1838, but any one ever remembered by the oldest inhabitants. There had been less rain than usual, the winter preceding, and although there were some good showers about the beginning of May, the ground was remarkably dry. In June, July, and August, but especially in the last two, we *suffered* for want of rain, and springs failed, that never failed before. The beautiful Aurora of Sept. 3, was followed by a copious rain in about 20 hours. Clear weather succeeded on the 9th, and there was no more rain until Nov. 1st, with the exception of light falls on the 17th, and 27th of Sept., and 27th Oct. With the 1st of November, the springs and creeks began to swell a little, and the popular opinion was that the rise was caused by the increase of cold. There was no rain in this vicinity sufficient to produce the effect, but there were rains at the time west of the mountains and north of us.

During November we had 3.64 inches of rain, and on the 25th day the Ther. fell to 9°, while the Bar. rose to 30.08 inches.

Such a temperature in November is very unusual—from May until this day the Ther. has not been so low, nor the Bar. as high. In December rain began at 8 P. M. on the 6th, and continued moderately until the 12th, changing into snow on the 9th at night, half an inch deep, (the first of the season) making of rain in all only .83in.

December, 12 and 13, cloudy—wind SW., SE., and East; 14th cloudy—SW.; 15th, clear—W.; 16th, cloudy—N. E.; 17th, clear—W.; Ther. 17 min. I state the above facts, because the newspapers inform us of a violent storm in the East on the 14th and 15th.

December 30th, a snow storm began here at day-break with an East and NE. wind, and continued until 4½ P. M., when it lay 7 inches deep. It was followed by hail all night.

December 31, a pretty thick crust on the snow; hail continued till 9 A. M., and then a light snow through the day, Bar. 29.36, at noon began to rise at 2 P. M., when it was 29.38, wind N.; cloudy all night, but clear this morning. The amount of rain in December 2.70 inches.

Mean temperature, June, 73.17; July, 77.88; August, 77.82; September, 65.58; October, 64.65; November, 41.11; December, 34.17; max. temp. of summer 95°—river too low for boats.

Very respectfully, Yours, &c.,

JAMES HAMILTON.

*Meteorological Observations, at the Winter Solstice of 1839, made in conformity with the instructions of the South African Literary and Philosophical Institution, at the University of Nashville, Tennessee, in North Latitude, 36° 09' 33", W. Long. 86° 49' 03;" by JAMES HAMILTON, Prof. Math. and N. Phil.*

December 21, 1839.

|        | External<br>Ther. | Attach'd<br>Ther. | Barom. |   |          |                                           |
|--------|-------------------|-------------------|--------|---|----------|-------------------------------------------|
| 6 A.M. | 35                | 39                | 29.22  | c | S.E.     | 0 Thin clouds.                            |
| 7      | 35.5              | 42                | 29.22  | c | S.E.     | 0 Clouds heavier; sprinkles, 7h. 25m.     |
| 8      | 36.5              | 42                | 29.21  | r | S.E.     | 0 Gentle rain.                            |
| 9      | 37.5              | 42                | 29.21  | r | S.E.     | 0 Rain heavier.                           |
| 10     | 39.5              | 42                | 29.21  | r | S.E.     | 0 Rain lighter; W. nearly cl'r. 10h. 40m. |
| 11     | 40.5              | 42                | 29.19  | c | S.W.S.E. | 0 Clouds thinner; mist 11h. 30m.          |
| 12     | 44                | 42                | 29.14  | c | S.E.     | 0                                         |
| 1 P.M. | 43.5              | 42                | 29.11  | c | S.       | 0 Clouds heavy.                           |
| 2      | 43                | 43                | 29.10  | c | S.       | 0 Clouds lighter.                         |
| 3      | 43.5              | 43                | 29.08  | c | S.E.     | 0 Double currents S, S.E. at 3h 30m.      |
| 4      | 43.3              | 44                | 29.07  | c | S.       | 0                                         |
| 5      | 41.5              | 44                | 29.07  | r | S.       | 0 Clouds breaking.                        |
| 6      | 41                | 44                | 29.05  | c | S.       | 0 Clouds thinner; sprinkle, 6h 30m.       |
| 7      | 40                | 44                | 29.05  | c | S.       | 0 Do. heavy some places, light others.    |
| 8      | 41.5              | 44                | 29.04  | c | SW.      | 1 Do. breaking in South.                  |
| 9      | 41                | 44                | 29.01  | r | SW.      | 1 Light rain.                             |
| 10     | 40.5              | 44                | 28.99  | r | SW.      | 1 Heavier rain.                           |
| 11     | 40                | 44                | 28.98  | c | SW.      | 1                                         |
| 12     | 40.5              | 45                | 28.98  | r | SW.      | 1                                         |

December 22.

|         |      |    |       |   |    |                                      |
|---------|------|----|-------|---|----|--------------------------------------|
| 1 A.M.  | 40   | 45 | 28.98 | c | W. | 2                                    |
| 2       | 39.5 | 46 | 29.01 | c | W. | 1                                    |
| 3       | 40.5 | 46 | 29.01 | c | W. | 1                                    |
| 4       | 38   | 44 | 29.04 | c | W. | 2                                    |
| 5       | 38.5 | 43 | 29.05 | c | W. | 1                                    |
| 6       | 38   | 43 | 29.06 | c | W. | 1 From 6h. 10m. to 6h. 25m. wind 2.  |
| 7       | 36.5 | 42 | 29.06 | r | W. | 1                                    |
| 9       | 35   | 41 | 29.11 | c | W. | 1 At 12h. 40m. a few flakes of snow. |
| 1 P. M. | 35   | 42 | 29.14 | c | W. | 3                                    |
| 3       | 34   | 42 | 29.20 | c | W. | 1                                    |

December 23.

|        |      |     |       |   |     |   |
|--------|------|-----|-------|---|-----|---|
| 8 A.M. | 36   | 38  | 29.50 | c | NW. | 1 |
| 9      | 31.5 | 35  | 29.53 | c | NW. | 1 |
| 10     | 32   | 35  | 29.53 | c | NW. | 1 |
| 11     | 32.5 | 35  | 29.53 | c | NW. | 1 |
| 12     | 33   | 35  | 29.52 | c | NW. | 1 |
| 1 P.M. | 33   | 35  | 29.50 | c | NW. | 1 |
| 2      | 34.5 | 35  | 29.50 | c | NW. | 1 |
| 3      | Do.  | Do. | Do.   |   | Do. |   |

December 24.

|        |    |    |       |   |    |   |
|--------|----|----|-------|---|----|---|
| 9 A.M. | 35 | 35 | 29.65 | c | W. | 1 |
| 12     | 36 | 35 | 29.62 | c | W. | 1 |
| 3 P.M. | 37 | 36 | 29.60 | c | W. | 1 |

December 25, min. 17.

Meantime found by means of transit, and kept by a superior clock, not varying 30 seconds in 6 weeks. Ther. Fahrenheit. Barometer of English manufacture; diameter of the tube  $\frac{4}{10}$  inch, cup. 2 inches; in good order; Dolland, London; height above ground 38 feet, and 128 feet above low water of the Cumberland river—external thermometer 35 feet above ground, facing North.

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## Mechanics' Register.

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LIST OF AMERICAN PATENTS WHICH ISSUED IN JANUARY, 1839,  
*With Remarks and Exemplifications by the Editor.*

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1. For an apparatus for *Evaporating Fluids*; William Henry, Laporte, Laporte county, Indiana, January 8.

The patentee tells us that "the nature of his improvement consists in so rarifying the air in the boiling apartment, by means of fires lighted therein, at the back, creating a strong draft through a flue, or flues, above the fire, which conduct off the steam rapidly from the surface of the liquid in the boiler, causes the evaporation to go on more expeditiously than heretofore, removes the nuisance and inconvenience arising from the steam in the manufactory, saves fuel, lessens the number of boilers required, and improves the quality of the sugar, salt, or other article manufactured." We have here a promising list of valuable results from the discovery patented. The matter is not very clearly explained, but the thing appears to consist in the making of an additional fire above, and behind, the tops of the boilers, so as to produce a more rapid draught up the chimney. The patentee says that the rapidity of the evaporation will be so far increased, that one pound of fuel burnt for rarifying the air will be as valuable as four under the boilers. We do not believe this, as according to our understanding of the matter, the rapidity of evaporation from a boiler is proportioned to the fire surface of the boiler, and the intensity of the fire; as to draught, it should be sufficient to carry off the vapour, and the fire under the boilers may certainly answer this purpose. The claim is to "the before described method of evaporating liquids, by rarifying the air in the boiling room."

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2. For an improvement in *Bedsteads*; Thomas Early, county of Williamson, Tennessee, January 8.

The subject of this patent seems to us to be one of the most trifling on record, although it wears the garb of novelty. At the distance of two or more inches from the posts of a low post bedstead, four high posts are to be placed, for the purpose of sustaining curtains. These high posts are to be attached to the low ones by iron straps at their lower ends; that is all. The advantage derived is the "allowing the bed covering to hang over the bedstead on all sides, without the interference of curtain posts, uniting *taste* with convenience." The claim is to "the adding to, or combining with, the common bedstead, curtain posts, as above described." Animadversion is not necessary.

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3. For a *Submarine Excavator*; William P. Brayton, and James Hamilton, city of New York, January 8.

This apparatus is intended for removing the dirt, or mud, from docks



and slips, and for clearing channels. It consists mainly of a platform, suitably framed, and having on its lower side scrapers, or buckets, which extend from side to side, hinged by one edge to the platform, the other edge being capable of being opened and closed. This platform may be suspended between scows, and let down and raised by means of windlasses, when on drawing it forward on the bottom of the dock, slip, or channel, the buckets, or scrapers, which stand in a range like the slats of a window blind, are to collect the dirt.

The claim is to "the application of said scrapers, or buckets, for the purpose aforesaid, and in combination with the platform, chains, and coulters, or pins, and with the other parts of the machine, as described."

We apprehend that this machine will be liable to serious objections. If made to operate in soft mud, nearly the whole, we think, will be washed out in raising the platform; in operating upon a bottom moderately hard, the resistance to the motion of the machine forward, will be greater than can be readily overcome.

4. For a machine for *Sharpening Curriers' Knives*; Warren Eggleston, city of Troy, New York, January 8.

A bench is to be prepared on which the knife may be secured, so that the edge, or side, to be rubbed may be placed, and held in the proper position for the action of the rub stone. This latter is attached to a suitable frame, which is guided by a rod, or wire, extending along on one side of the frame, the parts being so constructed as to allow a free motion to be given by hand to the rub stone, both lengthwise, and crosswise.

The claim is to "the combination of the bench with the rub stone, the whole being constructed and arranged in the manner substantially as described."

5. For packing and gearing *Mill Spindles*; David D. Wagner, city of Pittsburgh, Pennsylvania, January 8.

*Claim.* "The employment of the metal box attached to the bridge tree by keys, and moving longitudinally and transversely upon it, in combination with the mode of adjusting by means of screws, the carriage which holds the stepping of the lower pole of the spindle. Secondly, the employment of a metal bush containing packing through which the spindle is permitted to revolve, which packing may be tightened or slackened, even whilst the machine is in motion, by a follower acted upon by screws movable from without, as described."

There are several patents for devices the same in object with the foregoing, but the arrangement in that above mentioned has been deemed sufficiently new, to obtain the grant of a patent; we do not see any thing in it, however, demanding special notice.

6. For an improvement in the manufacture of *Cigars*; William D. Groff, Marietta, Lancaster county, Pennsylvania, January 8.

These cigars, are to be made like other cigars, but instead of the genuine Havana, the leaf of the sun-flower, or of Rhubarb, or of both combined, is to be used. The patentee, for the sake of those to whom long habit has rendered the taste of tobacco desirable, sometimes adds a wrapper of this material, but he claims, and will probably be allowed to smoke, "the prepared

leaves of the sun-flower, and rhubarb plant, separately or combined, for the formation of cigars, and to be used as a substitute for tobacco."

7. For a *Life and Anchor Boat*; Joseph Francis, city of New York, January 11.

The claim made is to "the adaptation and arrangement of air-tight tubes, with holes in the bottom of the boat, in combination, and in the manner and for the purpose set forth." The boat is to be rendered buoyant by means of closed metallic tubes, usually placed lengthwise of the boat, and in all cases occupying the bottom portion only. A flooring is to be laid above these tubes, and openings made through this flooring, and through the bottom of the boat, which openings are to be closed by plugs, on the withdrawal of which, any water that may have been shipped will run out, without baling, the buoyancy being such as to raise the floor above the surface of the water. The name of *Anchor boat*, is given, as it is intended to use this boat for carrying out an anchor from a ship, by suspending said anchor under the boat, by means of two hawsers, passing through the openings in its bottom; one hawser being attached to the stock, and the other to the fluke of the anchor.

8. For a *Glass Socket Lamp*; Henry Whitney, and Thomas Leighton, Cambridge, Middlesex county, Massachusetts, January 11.

"The nature of our invention consists in uniting the peg to the fount of a socket lamp, in such way as that the glass blower finishes both peg and fount, and completes the article by one simple operation of blowing it in a mould." The manipulation for effecting this object is fully described, and a claim made to "the peculiar mode described of making a socket lamp in such a way as to unite the fount and peg of the lamp, made of separate portions of glass, by one simple operation of blowing it in a mould."

9. For an *Excavating Machine*; G. W. Cherry, Washington, District of Columbia, January 16.

The main intention of this machine is for ditching and embanking, and it "consists chiefly in a wheel with cutters on the periphery to shape the bottom of the ditch, and cutters on the sides to shape the sides of the ditch." The different modes of forming this machine are represented in twenty-eight different figures, and the claims amount to twelve; these we do not copy, as they would not be explanatory, nor do we think it necessary to discuss the merits of the plan, or rather plans, as the project still remains an untried one, and we apprehend that it stands but little chance of going into actual operation.

10. For *Propelling Canal Boats*; Thomas Jackson, Reading, Berks county, Pennsylvania, January 18.

"My improvement consists in placing two wheels beside each other, under the stern of the boat, which wheels are to revolve in contrary directions perpendicular to a line of the boat from stem to stern; and in the application of dead woods, with their appurtenances, for protecting the wheels from the sides of the canal, tow lines, &c."

The wheels have vanes, like those of a windmill, inserted at an angle of about 60 degrees with the axle; the claim is to "the mode of applying wheels constructed and arranged as above described, to the stern of the

boat. Likewise the openings and slides in the deadwoods on each side, to admit water to pass through when the boat is heavily laden."

So far as such wheels are concerned, there is little or no novelty in the plan. The last claim refers to openings in the sides of the deadwood, which are closed by shutters when the boat is light, but which are opened to admit water to the wheels when the bottom of the boat is near to the bottom of the canal.

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11. For *Life Boats*; George Young, city of Philadelphia, Pennsylvania, January 21.

Copper tubes are to be employed to obtain buoyancy, as in the boat described under No. 7; but the patentee says, "Copper tubes having been previously employed for giving buoyancy to boats and other vessels, I do not claim the application of them for that purpose, but what I do claim in the construction of a life boat, as described, is the placing of tubes, or tanks, so as to extend from gunwale to gunwale, to the keelson, as herein set forth, in combination with the screw stoppers, either with or without valves, for the purpose, and in the manner made known. I claim, likewise, the openings in the bottom of the boat, in combination with sliding valves or shutters, and a rod, or handle for operating the same, constructed and located as described."

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12. For a *Churn*; Milo B. Hough, Dover, Cayahoga county, Ohio, January 21.

This is to be a vertical churn, within which are to be three vertical shafts, which are to be made to revolve by means of wheels and pinions. Each of the shafts is furnished with beaters, and at their upper ends, above the surface of the cream, is to be placed flat pieces, which are to operate as fans. The claim is to "the combination of the fans on the upper ends of the shafts, with the beaters, in the manner, and for the purpose described." In what way the fans are to promote the formation of the butter, we are not informed. As respects the application of several revolving shafts in this churn, there is no novelty in it, nor is there any thing in the whole affair which we can find cause to commend.

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13. For *Clips for the shafts of Carriages*; John Cooper, city of New York, January 22.

The claim under this patent is to "the so constructing the box joints, in shaft clips for carriages, as that the pipe eye, or connecting end of the shaft strap, shall not depend upon the bolt for its support, but, on the contrary, upon the box or case in which it is enclosed, in the manner described." The peculiarity of construction in this clip, cannot be shown without the drawings.

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14. For an improvement in *Saw Mills*; Eden Baldwin, Ashfield, Franklin county, Massachusetts, January 31.

The said improvement consists in an apparatus employed for setting the log to the saw, the description of which is made to occupy eight full pages of record. The claims alone would not afford any correct notion of the arrangement, and there is too much complexity in the affair to allow of verbal description, and, we think also, too much to admit of the extensive adoption of the plan.



Progress of Practical and Theoretical Mechanics and Chemistry.

*On the Strength and other Properties of Cast Iron obtained from the Hot and Cold Blast.* By WILLIAM FAIRBAIRN, Esq.

[CONCLUDED FROM VOL. XXIV, PAGE 397.] /

There cannot be a doubt that the phenomenon of cohesive force is strongly developed in the preceding tables; the minute crystalline particles of the bars are acted upon by loads, which, in the heavier weights, are almost sufficient to produce fracture: yet fracture is not (except in one instance) produced, and to what extent the power of resistance may yet be carried is left for time to determine. It nevertheless appears from the present state of the bars (which indicate a slow but progressive increase in the deflections) that we must at some period arrive at a point beyond their bearing powers; or otherwise to that position which indicates a correct adjustment of the particles in equilibrium with the load. Which of the two points we have in this instance attained is difficult to determine: sufficient data are however adduced to show that the weights are considerably beyond the elastic limit,\* and that cast iron will support loads to a much greater extent than what has usually been considered safe, or beyond that point where a permanent set takes place. But in whatever way this may be determined, it is obvious the preceding experiments give greater indications of strength than has generally been supposed cast iron would do; and should the bars continue to support the loads for a few years longer, there cannot exist a doubt as to the security of this metal under applications hitherto unknown; and the same may be said of other materials.

In the 14th Table we shall find inch square bars loaded on the middle, within a few pounds of weights sufficient to break them; we shall also find the bars considerably bent, and the resisting powers in full operation to sustain the load. Now the question to be determined by this experiment is, the nature of this resistance; and to show in the first instance whether the resisting power of the extended particles below, and the powers of the condensed ones operating above, are sufficient at all times *ad infinitum* to support the load; or whether those particles, instead of being united (as we suppose) with a permanent force, nicely balanced at all points of resistance, are not absolutely giving way; and by slow, though imperceptible degrees, becoming hourly weaker, until the cohesive power is entirely destroyed and rupture takes place.

It is not my intention in this place to offer any opinion upon the cohesive properties of matter, but simply to inquire how far the bearing powers of cast iron can be depended upon.

It is evident from these experiments that both sorts of hot and cold blast iron possess that power in a high degree; and we need only refer to the experiments for examples to show the patient tenacity with which so heavy a load is supported. At first sight it would appear, that the heavier loaded bars were progressively giving way, as the deflections continue to increase since the loads were permanently fixed; this defect is however not more conspicuous in the bars supporting 448 lbs., than in those supporting 392 lbs.;

\* The elastic limit is that point where bodies under strain lose the power to restore themselves when the load is removed; a property which is strongly exemplified in cast iron. It has been considered by many that materials cannot be loaded with safety beyond that point.



the deflection is even greater in the latter, arising in all probability from a greater degree of ductility in the bars.

I hope shortly to induce my friend Mr. Hodgkinson, Professor Barlow, or some other able mathematician, to investigate this subject, and by close analysis to demonstrate those truths, so essential to the interests of all engaged in the use of the metals, but more particularly in reference to the security of the public at large.

### *Effects of Temperature.*

When the multiplicity of objects to which cast iron is applied, and the innumerable situations in which it is placed, is considered, I may venture to state, that in every work of which cast iron forms the whole or a part of the structure, it is more or less liable to change. The rapidity with which it imbibes, and the facility with which it parts with caloric, is in itself a sufficient consideration for the labour I have bestowed upon these inquiries.

The present investigation would have been less satisfactory had the experiments on the effects of temperature been omitted; and I trust, the annexed Tables, which exhibit hot and cold blast iron under various gradations of heat, will not be without their uses in the future application of this material.

Rondelet, in his "*Traite de Bâtir*," has given and collected results from experiments, made by himself and others, on the expansion of bodies under the effects of heat; but I am not aware of any that have been made to ascertain the transverse strength of metallic substances under the various changes of temperature. It is well known that the effects of heat upon iron have not escaped the notice of philosophers; but I believe no writers on this subject have conducted their experiments in any way analogous to those now under consideration.

The celerity with which heat passes through the metals, and the frequent recurrence of iron being the medium of communication between fluids and this powerful agent, it is not surprising that the changes of temperature thus induced should cause such visible indications of deterioration in the material. Gas retorts, and all those vessels exposed to the alternate changes of the heating and cooling process, are considerably injured by the expansion and contraction of the parts; and no doubt the destruction of the metals is much accelerated when they are worked up to a high and excessive temperature. Probably steam-boilers are not so much injured as those above-mentioned, as the temperature is kept moderately low by the water they contain, which seldom exceeds  $212^{\circ}$ . The same causes are, nevertheless, in operation, and must continue to be so under the varied influences of caloric action.

Had time permitted, it was my intention to have pursued the experiments on temperature under a much greater degree of form and change than is here exhibited. For example, it might have been desirable not only to load the bars until they were broken, but also to charge them with different weights, and, by alternate heating and cooling, to have ascertained how far the bars so charged were affected by the change. Such an extension of the experiments might have led to the development of some new feature in the actions thus produced, and that more particularly by the introduction, abstraction, re-introduction, &c. of the different increments of heat. As it is, the bars were all broken at the temperatures indicated in the tables.

To determine the relative strengths of Coel-Talon Hot and Cold Blast Iron, to resist a transverse strain under different degrees of temperature.

|                                                                                |                                                                  |                                          |                                          |                                        |
|--------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------|------------------------------------------|----------------------------------------|
| No. 2 Iron,<br>Experiment 1.                                                   | No. 2 Iron,<br>Experiment 2.                                     | No. 2 Iron,<br>Experiment 3.             | No. 2 Iron,<br>Experiment 4.             | No. 2 Iron,<br>Experiment 5.           |
| Depth of bar, 1.068                                                            | Depth of bar, 1.020                                              | Depth of bar, 1.008                      | Depth of bar, 1.006                      | Depth of bar, 1.038                    |
| Breadth of do. 1.051                                                           | Breadth of do. 1.005                                             | Breadth of do. .996                      | Breadth of do. 1.021                     | Breadth of do. 1.023                   |
| Distance between supports, 2 ft. 3 in.                                         | Distance between supports, 2 ft. 3 in.                           | Distance between supports, 2 ft. 3 in.   | Distance between supports, 2 ft. 3 in.   | Distance between supports, 2 ft. 3 in. |
| Temp. Fahr. 26°                                                                | Temp. Fahr. 28°                                                  | Temp. Fahr. 32°                          | Temp. Fahr. 32°                          | Temp. Fahr. 114°                       |
| Permanent Set. ..                                                              | Permanent Set. +                                                 | Permanent Set. +                         | Permanent set. ..                        | Permanent set. ..                      |
| Deflection in inches. .034                                                     | Deflection in inches. .041                                       | Deflection in inches. .076               | Deflection in inches. .035               | Deflection in inches. .034             |
| Weight in lbs. 112                                                             | Weight in lbs. 112                                               | Weight in lbs. 112                       | Weight in lbs. 112                       | Weight in lbs. 112                     |
| 224                                                                            | 224                                                              | 224                                      | 224                                      | 224                                    |
| 336                                                                            | 336                                                              | 336                                      | 336                                      | 336                                    |
| 448                                                                            | 448                                                              | 448                                      | 448                                      | 420                                    |
| 560                                                                            | 560                                                              | 560                                      | 560                                      | 560                                    |
| 672                                                                            | 672                                                              | 672                                      | 672                                      | 672                                    |
| 784                                                                            | 784                                                              | 784                                      | 784                                      | 784                                    |
| 896                                                                            | 896                                                              | 896                                      | 896                                      | 896                                    |
| 938 broke                                                                      | 938 broke                                                        | 952 (380) broke                          | 980 (420) broke                          | 896 (.324) broke                       |
| Ultimate deflection = .385. This bar was broken in the open air during intense | Ultimate deflection = .487. This bar was broken in the open air. | This bar was broken when buried in snow. | This bar was broken when buried in snow. | Broken in water.                       |

The microscopic appearance of this iron will be found at No. I. Table, on the transverse strain.

*Results reduced to those of bars 1.00 in. square, and 2 ft. 3 in. between supports.*

|                            | Temp. | Specific gravity. | Modulus of elasticity. | Breaking Weight (b). | Ultimate deflection (d). | Product $b \times d$ , or power of resisting impact. |
|----------------------------|-------|-------------------|------------------------|----------------------|--------------------------|------------------------------------------------------|
| Experiment 1st, No. 2 Iron | 26°   | 6.955             | 12994400               | 851                  | .411                     | 349.8                                                |
| Experiment 2nd, No. 2 Iron | 28°   | ..                | 12603700               | 897                  | .4967                    | 445.6                                                |
| Mean,                      |       | 6.955             | 12799050               | 874                  | .4538                    | 397.7                                                |
| Experiment 3rd, No. 2 Iron | 32°   | 6.955             | 13506700               | 940.7                | .383                     | 360.3                                                |
| Experiment 4th, No 2 Iron  | 32°   | ..                | 15148200               | 958.5                | .422                     | 404.5                                                |
| Mean,                      |       | 6.955             | 14327450               | 949.6                | .402                     | 382.4                                                |
| Experiment 5th, No. 2 Iron | 113°  | 6.955             | 14168000               | 812.9                | .336                     | 273.1                                                |

TABLE XVI. Coed-Talon, Hot Blast.

| No. 2 Iron, Experiment 1.                                               |  |  |  | No. 2 Iron, Experiment 2.                             |  |  |  | No. 2 Iron, Experiment 3.                |  |  |  | No. 2 Iron, Experiment 4.                |  |  |  | No. 2 Iron, Experiment 5.              |  |  |  |
|-------------------------------------------------------------------------|--|--|--|-------------------------------------------------------|--|--|--|------------------------------------------|--|--|--|------------------------------------------|--|--|--|----------------------------------------|--|--|--|
| Depth of bar, 1.056                                                     |  |  |  | Depth of bar, 1.030                                   |  |  |  | Depth of bar, 1.033                      |  |  |  | Depth of bar, 1.020                      |  |  |  | Depth of bar, 1.006                    |  |  |  |
| Breadth of do. 1.004                                                    |  |  |  | Breadth of do. 1.010                                  |  |  |  | Breadth of do. 1.012                     |  |  |  | Breadth of do. 1.010                     |  |  |  | Breadth of do. 1.009                   |  |  |  |
| Distance between supports, 2 ft. 3 in.                                  |  |  |  | Distance between supports, 2 ft. 3 in.                |  |  |  | Distance between supports, 2 ft. 3 in.   |  |  |  | Distance between supports, 2 ft. 3 in.   |  |  |  | Distance between supports, 2 ft. 3 in. |  |  |  |
| Temp. Fahr. 16°                                                         |  |  |  | Temp. Fahr. 16°                                       |  |  |  | Temp. Fahr. 32°                          |  |  |  | Temp. Fahr. 32°                          |  |  |  | Temp. Fahr. 85°                        |  |  |  |
| Permanent Set. ∴ +.008                                                  |  |  |  | Permanent Set. ∴ +.008                                |  |  |  | Permanent Set. ∴ +.006                   |  |  |  | Permanent Set. ∴ +.005                   |  |  |  | Permanent Set. ∴ +.007                 |  |  |  |
| Deflection in inches. .030                                              |  |  |  | Deflection in inches. .035                            |  |  |  | Deflection in inches. .036               |  |  |  | Deflection in inches. .036               |  |  |  | Deflection in inches. .037             |  |  |  |
| Weight in lbs. 112                                                      |  |  |  | Weight in lbs. 112                                    |  |  |  | Weight in lbs. 112                       |  |  |  | Weight in lbs. 112                       |  |  |  | Weight in lbs. 112                     |  |  |  |
| 224                                                                     |  |  |  | 224                                                   |  |  |  | 224                                      |  |  |  | 224                                      |  |  |  | 224                                    |  |  |  |
| 336                                                                     |  |  |  | 336                                                   |  |  |  | 336                                      |  |  |  | 336                                      |  |  |  | 336                                    |  |  |  |
| 448                                                                     |  |  |  | 448                                                   |  |  |  | 448                                      |  |  |  | 448                                      |  |  |  | 448                                    |  |  |  |
| 560                                                                     |  |  |  | 560                                                   |  |  |  | 560                                      |  |  |  | 560                                      |  |  |  | 560                                    |  |  |  |
| 672                                                                     |  |  |  | 672                                                   |  |  |  | 672                                      |  |  |  | 672                                      |  |  |  | 672                                    |  |  |  |
| 784                                                                     |  |  |  | 784                                                   |  |  |  | 784                                      |  |  |  | 784                                      |  |  |  | 784                                    |  |  |  |
| 896                                                                     |  |  |  | 882                                                   |  |  |  | 896                                      |  |  |  | 896                                      |  |  |  | 896                                    |  |  |  |
| broke                                                                   |  |  |  | broke                                                 |  |  |  | broke                                    |  |  |  | broke                                    |  |  |  | broke                                  |  |  |  |
| ∴ Ultimate deflection = .366. This bar was broken during intense frost. |  |  |  | ∴ Ultimate deflection = .402. Broken in the open air. |  |  |  | ∴ Ultimate deflection = .422) broke      |  |  |  | ∴ Ultimate deflection = .415) broke      |  |  |  | ∴ Ultimate deflection = .419) broke    |  |  |  |
| This bar was broken when buried in snow.                                |  |  |  | This bar was broken when buried in snow.              |  |  |  | This bar was broken when buried in snow. |  |  |  | This bar was broken when buried in snow. |  |  |  | Broken in water.                       |  |  |  |

Results reduced to those of bars 1.00 in. square, and 2 ft. 3 in. between supports.

|                            | Temp. | Specific gravity. | Modulus of elasticity. | Breaking weight (b). | Ultimate deflection (d). | Product $b \times d$ , or power of resisting impact. |
|----------------------------|-------|-------------------|------------------------|----------------------|--------------------------|------------------------------------------------------|
| Experiment 1st, No. 2 Iron | 16°   | 6.968             | 15538300               | 800.29               | .3865                    | 309.3                                                |
| Experiment 2nd, No. 2 Iron | 24°   | ..                | 14267500               | 823.10               | .4140                    | 340.8                                                |
| Mean,                      |       | 6.968             | 14902900               | 811.69               | .4002                    | 325.0                                                |
| Experiment 3rd, No. 2 Iron | 32°   | 6.968             | 13723500               | 933.4                | .436                     | 406.9                                                |
| Experiment 4th, No. 2 Iron | 32°   | ..                | 14283200               | 906.0                | .423                     | 383.2                                                |
| Mean,                      |       | 6.968             | 14003350               | 919.7                | .429                     | 395.0                                                |
| Experiment 5th, No. 2 Iron | 84°   | 6.968             | 14500000               | 877.5                | .421                     | 369.4                                                |

The infusion of heat into a metallic substance may render it more ductile, and probably less rigid in its nature; and I apprehend it will be found weaker, and less secure under the effects of heavy strain. This is observable to a considerable extent in the experiments ranging from  $26^{\circ}$  up to  $190^{\circ}$  of temperature.

The cold blast at  $26^{\circ}$  and  $190^{\circ}$ , is in strength as 874 : 743,

The hot blast at  $21^{\circ}$  and  $190^{\circ}$ , is in strength as 811 : 731;

being a diminution in strength as 100 : 85 for the cold blast, and 100 : 90 for the hot blast, or 15 per cent. loss of strength in the cold blast, and 10 per cent. in the hot blast.

TABLE XVII. Coed-Talon Cold Blast.

To determine the relative strengths of Coed-Talon hot and cold blast iron to resist the transverse strain under different degrees of temperature.

| No. 2 Iron.                           |                         | No. 3 Iron.                          |               | No. 3 Iron.                         |               | No. 2 Iron.                                                                                                                                            |     | No. 2 Iron.                                                                                 |     |
|---------------------------------------|-------------------------|--------------------------------------|---------------|-------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---------------------------------------------------------------------------------------------|-----|
| Experiment 6.                         |                         | Experiment 7.                        |               | Experiment 9.                       |               | Experiment 11.                                                                                                                                         |     | Experiment 12.                                                                              |     |
| Depth bar, 1.030                      |                         | Depth bar, .995                      |               | Depth bar, 1.015                    |               | Depth bar, 1.004                                                                                                                                       |     | Depth bar, 1.026                                                                            |     |
| Breadth of do. 1.030                  |                         | Breadth 1.005                        |               | Breadth 1.021                       |               | Breadth 1.005                                                                                                                                          |     | Breadth 1.030                                                                               |     |
| Distance between supports 2 ft. 3 in. |                         | Distance between supports, 2ft. 3in. |               | Distance between supports, 2ft 3in. |               | Distance between supports, 2ft 3in.                                                                                                                    |     | Distance between supports, 2ft. 3in.                                                        |     |
| Weight in lbs.                        | Temperature Fahrenheit. | Weight in lbs.                       | Tem           | Weight in lbs.                      | Tem           | Weight in lbs.                                                                                                                                         | Tem | Weight in lbs.                                                                              | Tem |
|                                       | Permanent Set.          |                                      |               |                                     |               |                                                                                                                                                        |     |                                                                                             |     |
| 112 .034                              | ..                      | 900 broke                            | $212^{\circ}$ | 956 broke                           | $600^{\circ}$ | 672 broke it,                                                                                                                                          |     | 784 broke.                                                                                  |     |
| 224 .069                              | ..                      | Broke in boiling water.              |               | Broke in melted lead.               |               | after the weight had been on half a minute. The deflection was considerable. The weight was laid on at once. This bar was perceptibly red by daylight. |     | This bar was a deep orange colour in the dark. There was no time to measure the deflection. |     |
| 336 .106                              | +                       | No. 3 Iron.                          |               | No. 3 Iron.                         |               | No. 3 Iron.                                                                                                                                            |     | No. 3 Iron.                                                                                 |     |
| 448 .144                              | .009                    | Experiment 8.                        |               | Experiment 10.                      |               | Experiment 10.                                                                                                                                         |     | Experiment 10.                                                                              |     |
| 560 .185                              | .011                    | Depth bar, .995                      |               | Depth bar, .987                     |               | Depth bar, .987                                                                                                                                        |     | Depth bar, .987                                                                             |     |
| 672 .231                              | .016                    | Breadth 1.000                        |               | Breadth .997                        |               | Breadth .997                                                                                                                                           |     | Breadth .997                                                                                |     |
| 784 .281                              | .021                    | Distance between supports, 2ft. 3in. |               | Distance between supports, 2ft 3in. |               | Distance between supports, 2ft 3in.                                                                                                                    |     | Distance between supports, 2ft 3in.                                                         |     |
| 812 .293                              | broke                   | Weight in lbs.                       |               | Weight in lbs.                      |               | Weight in lbs.                                                                                                                                         |     | Weight in lbs.                                                                              |     |
| Broke in hot water.                   |                         | 934 broke                            |               | 1124 broke                          |               | 1124 broke                                                                                                                                             |     | 1124 broke                                                                                  |     |
|                                       |                         | $212^{\circ}$                        |               | $600^{\circ}$                       |               | $600^{\circ}$                                                                                                                                          |     | $600^{\circ}$                                                                               |     |
|                                       |                         | Broke in boiling water.              |               | Broke in melted lead.               |               | Broke in melted lead.                                                                                                                                  |     | Broke in melted lead.                                                                       |     |

Coed-Talon No. 3 cold blast iron exhibits greater density in the arrangement of its crystalline texture than the No. 2. Colour a whitish gray, interspersed with a number of minute luminous crystals.



Results reduced to those of bars 1.00 inch square, and 2 feet 3 inches between supports.

|                     | Temperature<br>Fahrenheit. | Modulus of<br>elasticity. | Breaking<br>weight<br>(b). | Ultimate<br>deflection<br>(d). | Product<br>$b \times d$ , or<br>power of<br>resisting<br>impact. |
|---------------------|----------------------------|---------------------------|----------------------------|--------------------------------|------------------------------------------------------------------|
| Experiment 6 . . .  | 193° — 191°                | 14398600                  | 743.1                      | .301                           | 223.7                                                            |
| Experiment 7 . . .  | 212°                       |                           | 905.0                      |                                |                                                                  |
| Experiment 8 . . .  | 212°                       |                           | 944.0                      |                                |                                                                  |
| Mean.               |                            |                           | 924.5                      |                                |                                                                  |
| Experiment 9 . . .  | 600°                       |                           | 909.0                      |                                |                                                                  |
| Experiment 10 . . . | 600°                       |                           | 1157.0                     |                                |                                                                  |
| Mean,               |                            |                           | 1033.                      |                                |                                                                  |
| Experiment 11 . . . | Red by daylight.           |                           | 663.3                      |                                |                                                                  |
| Experiment 12 . . . | Red in dark.               |                           | 723.1                      |                                |                                                                  |

TABLE XVIII. Coed-Talon Hot Blast.

| No. 2 Iron,<br>Experiment 6.                     |      |       |      | No. 2 Iron,<br>Experiment 7.                     |      |       |      | No. 2 Iron,<br>Experiment 8.                     |       |      |      | No. 3 Iron,<br>Experiment 9.                     |      |           |      | No. 3 Iron,<br>Experiment 11.                    |  |  |  |
|--------------------------------------------------|------|-------|------|--------------------------------------------------|------|-------|------|--------------------------------------------------|-------|------|------|--------------------------------------------------|------|-----------|------|--------------------------------------------------|--|--|--|
| Depth of bar, 1.007                              |      |       |      | Depth of bar, 1.038                              |      |       |      | Depth of bar, 1.019                              |       |      |      | Depth bar, .993                                  |      |           |      | Depth bar, .986                                  |  |  |  |
| Breadth of do. 1.009                             |      |       |      | Breadth of do. 1.017                             |      |       |      | Breadth of do. 1.015                             |       |      |      | Breadth do. .991                                 |      |           |      | Breadth do. .997                                 |  |  |  |
| Distance between supports, 2 ft. 3 in.           |      |       |      | Distance between supports, 2 ft. 3 in.           |      |       |      | Distance between supports, 2 ft. 3 in.           |       |      |      | Distance between supports, 2 ft. 3 in.           |      |           |      | Distance between supports, 2 ft. 3 in.           |  |  |  |
| Temperature Fahrenheit.                          |      |       |      | Temperature Fahrenheit.                          |      |       |      | Temperature Fahrenheit.                          |       |      |      | Temperature Fahrenheit.                          |      |           |      | Temperature Fahrenheit.                          |  |  |  |
| Permanent Set.                                   |      |       |      | Permanent Set.                                   |      |       |      | Permanent Set.                                   |       |      |      | Permanent Set.                                   |      |           |      | Permanent Set.                                   |  |  |  |
| Deflection in inches.                            |      |       |      | Deflection in inches.                            |      |       |      | Deflection in inches.                            |       |      |      | Deflection in inches.                            |      |           |      | Deflection in inches.                            |  |  |  |
| Weight in lbs.                                   |      |       |      | Weight in lbs.                                   |      |       |      | Weight in lbs.                                   |       |      |      | Weight in lbs.                                   |      |           |      | Weight in lbs.                                   |  |  |  |
| 112.041                                          | .041 | .006  | 138° | 112.044                                          | .044 | .009  | 186° | 122.037                                          | .037  | .003 | 196° | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 224.082                                          | .082 | .010  |      | 224.094                                          | .094 | .012  | 187  | 224.075                                          | .075  | .005 |      | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 336.123                                          | .123 | .017  |      | 336.142                                          | .142 | .018  |      | 336.115                                          | .115  | .005 | 195  | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 448.164                                          | .164 | .021  |      | 448.198                                          | .198 | .026  |      | 448.151                                          | .151  | .010 |      | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 560.215                                          | .215 | .031  | 138  | 560.263                                          | .263 | .041  |      | 560.205                                          | .205  | .018 |      | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 672.271                                          | .271 | .036  |      | 672.333                                          | .333 | .041  |      | 672.255                                          | .255  | .024 | 192  | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 784.329                                          | .329 | .051  |      | 784.333                                          | .333 | .041  |      | 784.314                                          | .314  | .038 | 190  | 800 broke                                        | 212° | 889 broke | 600° | 896 broke                                        |  |  |  |
| 896                                              |      | broke | 134  | 700                                              |      | broke |      | 868                                              | broke |      |      | 811 broke                                        | 600° | 896 broke | 600° | 896 broke                                        |  |  |  |
| ∴ Ultimate deflection = 386. Broke in hot water. |      |       |      | ∴ Ultimate deflection = 346. Broke in hot water. |      |       |      | ∴ Ultimate deflection = 356. Broke in hot water. |       |      |      | ∴ Ultimate deflection = 336. Broke in hot water. |      |           |      | ∴ Ultimate deflection = 336. Broke in hot water. |  |  |  |

This iron presents an appearance of greater ductility and softness than the No. 3, cold blast. From the blue tinge which the fracture exhibits, it is evidently an iron possessing the powers of being worked to a greater degree than the cold blast.

*Results reduced to those of bars 1.00 inch square, and 2 feet 3 inches between supports.*

|                               | Temperature<br>Fahrenheit. | Modulus of<br>elasticity. | Breaking<br>weight<br>( <i>b</i> ) | Ultimate<br>deflection<br>( <i>d</i> ). | Product<br>$b \times d$ or<br>power of<br>resisting<br>impact. |
|-------------------------------|----------------------------|---------------------------|------------------------------------|-----------------------------------------|----------------------------------------------------------------|
| Experiment 6, bar No. 2 iron  | 138° — 134°                | 13046200                  | 875.7                              | .389                                    | 340.6                                                          |
| Experiment 7, bar No. 2 iron  | 186 — 188                  | 11012500                  | 638.8                              | .359                                    | 229.3                                                          |
| Experiment 8, bar No. 2 iron  | 196 — 190                  | 13869500                  | 823.6                              | .363                                    | 298.9                                                          |
| Experiment 9, bar No. 3 iron  | 212°                       |                           | 818.4                              |                                         |                                                                |
| Experiment 10, bar No. 3 iron | 600                        |                           | 834.1                              |                                         |                                                                |
| Experiment 11, bar No. 3 iron | 600                        |                           | 917.5                              |                                         |                                                                |
| Mean,                         |                            |                           | 875.8                              |                                         |                                                                |
| Experiment 12, bar No. 2 iron | Red in dark                |                           | 829.7                              |                                         |                                                                |

In pursuing the experiments, it unfortunately occurred that the stock of No. 2 Coed-Talon metal became exhausted, a circumstance which interrupts the comparisons from below the freezing point to that of melted lead. The No. 3 should have been broken at all the points of temperature, in order to have ascertained the loss of strength sustained upon this iron by the increase of heat. This was, however, not accomplished, and we can now only compare the two qualities, No. 2 and No. 3, at the boiling point of water, and then proceed to the temperature of melted lead. I have already noticed that a considerable failure of the strength took place after heating the No. 2 iron from 26° to 190°. At 212° we have, in the No. 3, a much greater weight sustained than what is indicated by the No. 2 at 190°; and at 600° there appears in both hot and cold blast the anomaly of increased strength as the temperature is advanced from boiling water to melted lead, arising from the greater strength of the No. 3 iron.

A number of the experiments made on No. 3 iron of different sorts have given extraordinary and not unfrequently unexpected results. Generally speaking it is an iron of an irregular character, and presents less uniformity in its texture than either the first or second qualities; in other respects it is more retentive, and is often used for giving strength and tenacity to the finer metals.

Recurring to the No. 2 iron, it will be observed that the strength continued to diminish as the temperature was increased. Heating the cold blast iron in Experiments 11 and 12 to a perceptibly red colour, we have the breaking weights 663 and 723; whereas, in the hot blast, at nearly the same temperature, the breaking weight is 829.7, being as 693 (the mean) to 829, or in the ratio of 1000 : 1289.

From the experiments in Table 1, it appears that a bar of cold blast iron 1 inch square and 2 feet 3 inches between the supports, broke at the ordinary temperature of the atmosphere with 836.9, and in No. 3 cold blast from Table III, the breaking weight is 1137.3. This gives an excess of strength for the No. 3 iron of at least one-fourth.

When the bars were heated to a blood red the utmost care was taken to break them without loss of time. In every instance the deflection was considerable; rather more than  $1\frac{1}{2}$  inches was observed on the 2 feet 3 inches bars before they gave way.

*Comparative strength and power to resist impact of the Coed-Talon hot and cold blast irons, at various temperatures.*

**Transverse Strengths.**

| Temperature. | Coed-Talon Cold Blast. | Coed-Talon Hot Blast. | Ratio.       |
|--------------|------------------------|-----------------------|--------------|
| Fahrenheit.  | No. 2 Iron.            | No. 2 Iron.           |              |
| 26°          | 851.                   | 823.1                 | 1000 : 967.2 |
| 32           | 940.7 } Mean           | 933.4 } Mean          | 1000 : 977.6 |
| 190          | 958.5 } 949.6          | 906.0 } 919.7         | 1000 : 110.8 |
| Red in dark  | 743.1                  | 823.6                 |              |
|              | 723.1                  | 829.7                 |              |
|              | No. 3 Iron.            | No. 3 Iron.           |              |
| 212          | 905.0 } Mean           | 818.4                 | 1000 : 885.4 |
|              | 943.6 } 924.3          | 834.1 } Mean          | 1000 : 847.7 |
| 600          | 909.3 }                | 917.5 }               |              |
|              | 1157.0 } 1033.1        | 875.8                 |              |

**Power to resist impact.**

| Temperature. | Coed-Talon Cold Blast. | Coed-Talon Hot Blast. | Ratio.      |
|--------------|------------------------|-----------------------|-------------|
| Fahrenheit.  | No. 2 Iron.            | No. 2 Iron.           |             |
| 26°          | 349.8                  | 340.8                 | 1000 : 974  |
| 32           | 360.3 } Mean           | 406.9 } Mean          | 1000 : 1032 |
| 190          | 404.5 } 382.4          | 383.2 } 395.0         | 1000 : 1336 |
|              | 223.7                  | 298.9                 |             |

**Modulus of elasticity in lbs, for a base of 1 inch square.**

| Temperature. | Coed-Talon Cold Blast. | Coed-Talon Hot Blast. |
|--------------|------------------------|-----------------------|
| Fahrenheit.  | No. 2 Iron.            | No. 2 Iron.           |
| 26°          | 12994400               | 14267500              |
| 32           | 13506700 } Mean        | 13723500 } Mean       |
| 190          | 15148200 } 14327450    | 14283200 } 14003350   |
|              | 14398600               | 13869500              |

The above summary of results on the strength of the hot and cold blast irons is, with one exception, in favour of the cold blast. On the other hand, the power to resist impact appears, with one exception, also, on the side of the hot blast.

Having prosecuted these inquiries through a considerable range both of time and temperature, and having united my efforts to those of Mr. Hodgkinson on the transverse strain, I shall, before closing this report, give a general summary, with the results of which he has kindly favoured me, from all the irons experimented upon in this way.

Those results will exhibit in one column the relative and proportionate strength of each iron, and in the other the ratio of the forces to resist impact. Before closing the experiments, it may, however, be proper to state, in addition to the methods described in the preceding inquiry, that of grinding was adopted. For this purpose, an apparatus was made to grind each iron under an equal pressure, in order to ascertain the comparative resistances of different specimens of the same size, as compared with the results from chipping and filing given before. This was done with equal weights, upon

equal sections, and during equal periods of time; and each piece was carefully weighed, in order to determine which of the irons was most easily reduced. Notwithstanding the care taken to ensure correct results, I was unable to procure data from which any thing satisfactory could be obtained. For instance, in the Coed-Talon, Elsicar, and Milton irons, each specimen (nearly cubical) was reduced, as in the Table below, where W is a constant weight.

|                                        | Weight before grinding. | Weight after grinding. | Loss.   |
|----------------------------------------|-------------------------|------------------------|---------|
|                                        | Grains.                 | Grains.                | Grains. |
| Coed-Talon No. 2 cold blast iron . . . | W + 56                  | W - 161                | 217     |
| Coed-Talon No. 2 hot blast do. . . .   | W + 264                 | W + 128                | 136     |
| Elsicar cold blast do. . . .           | W + 155                 | W + 14                 | 141     |
| Milton hot blast do. . . .             | W + 211                 | W + 73                 | 133     |

The above results, selected from upwards of fifty experiments, are given, not for the purpose of comparison, but in order to enable others to follow up the experiments with greater success. I am of opinion that something may be done in this way; providing cast-steel cutters are used instead of a grindstone, the interstices of which become filled with metallic particles during the process, as the specimens are reduced; consequently the surface of the stone becomes smoother, and the angular points blunted.

*General summary of results, as derived from the experiments on the transverse strength of hot and cold blast iron.*

|                                                    |                        |       | Ratio of strength, that of the cold blast being represented by 1000. | Ratio of powers to sustain impact; (cold blast being 1000.) |
|----------------------------------------------------|------------------------|-------|----------------------------------------------------------------------|-------------------------------------------------------------|
| These irons are from Mr. Hogdkinson's experiments. | Carron iron,           | No. 2 | 1000 : 990.9                                                         | 1000 : 1005.1                                               |
|                                                    | Devon do.              | No. 3 | 1000 : 1416.9                                                        | 1000 : 2785.6                                               |
|                                                    | Buffery do.            | No. 1 | 1000 : 930.7                                                         | 1000 : 962.1                                                |
|                                                    | Coed-Talon do.         | No. 2 | 1000 : 1007                                                          | 1000 : 1234                                                 |
|                                                    | Coed-Talon do.         | No. 3 | 1000 : 927                                                           | 1000 : 925                                                  |
|                                                    | Elsicar and Milton do. |       | 1000 : 818                                                           | 1000 : 875                                                  |
|                                                    | Carron do.             | No. 3 | 1000 : 1181                                                          | 1000 : 1201                                                 |
|                                                    | Muirkirk do.           | No. 1 | 1000 : 927                                                           | 1000 : 823                                                  |
| Mean,                                              |                        |       | 1000 : 1024.8                                                        | 1000 : 1226.3                                               |

The ultimatum of our inquiries made in this way, stand, therefore, in the ratio of strength, as 1000 for the cold blast, to 1024.8 for the hot blast; leaving the small fractional difference of 24.8 in favour of the hot blast.\*

The relative powers to sustain impact are likewise in favour of the hot blast, being in the ratio of 1000 to 1226.3.

For the ratios of the powers of the hot and cold blast irons to resist a transverse strain for an indefinite period of time, and for the resisting powers of the same iron under variable temperatures, I must refer the reader to the results contained in their respective tables.

### *Engravings in Relief from Copperplates by means of Voltaic Electricity.*

We lately published (No. 624) M. Jacobi's letter to Mr. Faraday, in

\* The extraordinary properties of the Devon No. 3 iron in a great measure account for the difference which occurs between the strengths, as also the comparative powers to resist impact.



which he described his attempts to copy in relief engraved copperplates, by means of voltaic electricity. We have since received a communication from Mr. Thomas Spencer, of Liverpool, from which it appears, that that gentleman has for some time been independently engaged on the same subject; and that he has not only succeeded in doing all that M. Jacobi has done, but has successfully overcome those difficulties which arrested the progress of the latter. It is unnecessary here to enter on the question of priority between these gentlemen. To Mr. Spencer much credit is certainly due for having investigated, and successfully carried out, an application of voltaic electricity, the value of which can hardly be questioned. The objects which Mr. Spencer says he proposed to effect, were the following:—“To engrave in relief upon a plate of copper—to deposit a voltaic copperplate, having the lines in relief—to obtain a fac-simile of a medal, reverse or obverse, or of a bronze cast—to obtain a voltaic impression from plaster or clay—and to multiply the number of already engraved copperplates.” The results which he has obtained are very beautiful; and some copies of medals which he has forwarded to us are remarkably sharp and distinct, particularly the letters, which have all the appearance of having been struck by a die.

Without entering into a detail of the steps by which Mr. Spencer brought his process to perfection, many of which are interesting, as showing how slight a cause may modify the result, we shall at once give a description of his process.

Take a plate of copper, such as is used by an engraver; solder a piece of copper wire to the back part of it, and then give it a coat of wax—this is best done by heating the plate as well as the wax—then write or draw the design on the wax with a black lead pencil or a point. The wax must now be cut through with a graver or steel point, taking special care that the copper is thoroughly exposed in every line. The shape of the tool or graver employed must be such that the lines made are not V-shaped, but as nearly as possible with parallel sides. The plate should next be immersed in dilute nitric acid,—say three parts water to one acid: it will at once be seen whether it is strong enough, by the green colour of the solution and the bubbles of nitrous gas evolved from the copper. Let the plate remain in it long enough for the exposed lines to get slightly corroded, so that any minute portions of wax which might remain may be removed. The plate thus prepared is then placed in a trough separated into two divisions by a porous partition of plaster of Paris or earthenware,—the one division being filled with a saturated solution of sulphate of copper, and the other with a saline or acid solution. The plate to be engraved is placed in the division containing the solution of the sulphate of copper, and a plate of zinc of equal size is placed in the other division. A metallic connexion is then made between the copper and zinc plates, by means of the copper wire soldered to the former; and the voltaic circle is thus completed. The apparatus is then left for some days. As the zinc dissolves, metallic copper is precipitated from the solution of the sulphate on the copper plate, wherever the varnish has been removed by the engraving tool. After the voltaic copper has been deposited in the lines engraved in the wax, the surface of it will be found to be more or less rough, according to the quickness of the action. To remedy this, rub the surface with a piece of smooth flint or pumice-stone with water. Then heat the plate, and wash off the wax ground with spirits of turpentine and a brush. The plate is now ready to be printed from at an ordinary press.

In this process, care must be taken that the surface of the copper in the

lines be perfectly clean, as otherwise the deposited copper will not adhere with any force, but is easily detached when the wax is removed. It is in order to ensure this perfect cleanness of the copper, that it is immersed in dilute nitric acid. Another cause of imperfect adhesion of the deposited copper, which Mr. Spencer has pointed out, is the presence of a minute portion of some other metal, such as lead, which, by being precipitated before the copper, forms a thin film, which prevents the adhesion of the subsequently deposited copper. This circumstance may, however, be turned to advantage in some of the other applications of Mr. Spencer's process, where it is desirable to prevent the adhesion of the deposited copper.

In copying a coin or medal, Mr. Spencer describes two methods: the one is by depositing voltaic copper on the surface of the medal, and thus forming a mould, from which fac-similes of the original medal may readily be obtained by precipitating copper into it. The other is even more expeditious. Two pieces of clean milled sheet lead are taken, and the medal being placed between them, the whole is subjected to pressure in a screw press, and a complete mould of both sides is thus formed in the lead, showing the most delicate lines perfect (in reverse). Twenty, or even a hundred of these, may be so formed on a sheet of lead, and the copper deposited by the voltaic process with the greatest facility. Those portions of the surface of the lead which are between the moulds, may be varnished to prevent the deposition of the copper, or a whole sheet of voltaic copper having been deposited, the medals may afterwards be cut out. When copper is to be deposited on a copper mould or medal, care must be taken to prevent the metal deposited adhering. This Mr. Spencer effects by heating the medal, and rubbing a small portion of wax over it. This wax is then wiped off, a sufficient portion always remaining to prevent adhesion.

Enough has been said to enable any one to repeat and follow up Mr. Spencer's interesting experiments. The variations, modifications, and adaptations of them are endless, and many new ones will naturally suggest themselves to every scientific reader; and for their gratification, the medals produced by this process, and forwarded to us by Mr. Spencer, will be left with our publisher for some days, and open to inspection.

Athenæum.

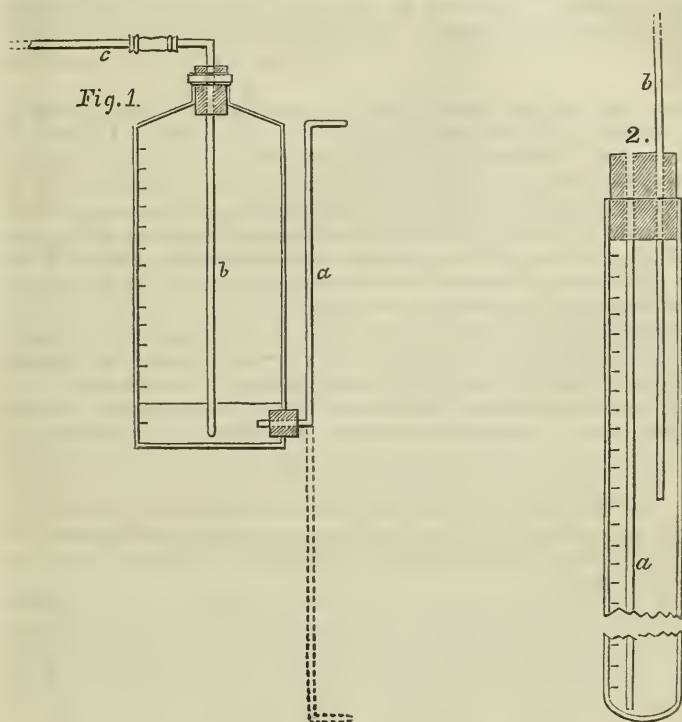
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ARTICLES FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

*Description of two instruments for finding and determining the Gases that issue from the ground; and the Carbonic Acid of Mineral Waters. By H. ABICH.*

To remedy the difficulty experienced in ascertaining the escape of elastic fluids from Solfaterras, Volcanoes, Marshes, &c., and to collect the gases from all such localities, without any access of atmospheric air, the author recommends the following apparatus. A strong glass bottle, fig 1, as cylindrical as possible, is perforated in the side near the bottom. A cork is made to fit this opening very accurately, through which passes a tube, *a*, twice bent at right angles, as in the figure. The upper angle is on a level with the lower part of the cork which closes the neck of the bottle. The tube *b* which passes through the cork in the neck descends to the bottom of the bottle, while to its outer end is adapted a gum elastic tube to facilitate a juncture with a prolonged and bent tube *c*. This tube *c* may be pressed deeply into the ground or opening to receive the gas, or it may be connected

with a funnel for its more rapid collection: As soon as the gas is found to escape through this tube freely, it may be joined to *b*, and by turning the tube *a* downwards (as represented by the dotted lines) the water or mercury will flow out as the gas enters, and its access may be immediately stopped by raising *a* to its former position. The tube *c* may be disengaged without risk of an escape of the gas, as long as *b* remains covered at bottom by a sufficient depth of fluid.



It will be readily understood that by means of a graduated tube or flask and a little pneumatic mercurial apparatus, formed of a capsule of hard wood, even the quantitative analysis of a mixture of gasses may be easily made on the spot. The quantity of carbonic acid, for example, (if it be not mixed with other gases absorbable by potash) may be determined by collecting the gas over mercury, and after placing the graduated flask in the capsule of mercury, cutting the tube very near the bottom, to observe the absorption of the carbonic acid whose volume is immediately announced by the scale of the bottle itself.

When solutions of reagents are used in the bottle for collecting the gas, the apparatus becomes still more appropriate for determining the presence of different gases in mixture. It is easy to increase the amount of the precipitate by passing fresh volumes of the gas through the liquid, and I am persuaded that in this way approximate conclusions may be made of the quantity of certain gases in a given volume of the mixture.

By the aid of this little apparatus I have often satisfied myself of the



presence of carbonic, hydrochloric, sulphuric, and hydrocyanic acids in the vapours of places where the common means of collecting gases could have given no satisfactory result. Hence I may venture to recommend the instrument to travelling geologists, who can seldom carry with them, conveniently, any complicated apparatus. Two or three bottles adjusted as above, a few tubes of different diameters, previously bent and drawn to a fine point, to be enlarged or hermetically closed by the blow pipe as occasion requires, a bottle of distilled or rain water, and a few concentrated solutions of reagents, are in almost every case sufficient, and may be transported without difficulty to places which promise a rich field for researches of this nature.

I will here add the description of an instrument which I have successfully used for determining the free carbonic acid in mineral waters. If not perfect in all its parts it enables one to precipitate very promptly and simply, and without the least possible loss, the carbonic acid in the spring itself. A cylinder (fig. 2) of sufficient width, is carefully graduated and nicely closed by a well fitted cork, through which passes two open tubes, *a* and *b*, the first terminating at the top of the cork and descending to the bottom of the cylinder; the second of about the same length, movable up and down through the cork, without allowing air to pass.

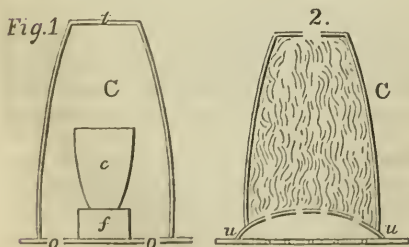
Learn, from previous experiment, how much of a solution of the chloride of barytes mixed with ammonia, must be employed to precipitate all the carbonic acid in a volume of water equal to the capacity of the cylinder.

A quantity a little more than sufficient for this purpose, is poured into the cylinder, and exactly measured by means of the scale; then withdraw the tube *b* till its lower opening is near the cork, and plunge the instrument into the spring until the end of the tube is just even with the surface of the water. When the fluid rises in the cylinder to the lower end of the tube *b*, all the free carbonic acid, as also the alkaline and earthy carbonates and bicarbonates contained in the water will be perfectly precipitated without the loss of the least portion of them.

Withdraw the instrument, and let the precipitate subside; then separate it by filtration and keep it, for examination, in a ground stoppered vial. It is hardly necessary to add that it must be the object of a separate analysis to determine the quantity of carbonates and bicarbonates in the water, to be able to correct the carbonic acid obtained by the precipitate.

*Ann. de Chémie.*

*An easy method of using a common Furnace as a muffle Furnace. By*  
GAY LUSSAC.



Let *C*, (fig. 1) be a common crucible at the bottom of which a little hole *t* is pierced. It may serve for a muffle on many occasions.

If a calcination is to be performed in a small crucible *c*, place it on a little earthen block *f*, and cover it with the crucible *C*. Place them on the grate of a furnace, and urge the fire as it may be necessary. The air enters the crucible by the openings *o, o*, of the grate, and escapes by the upper hole *t*, so that the vitiated air is constantly removed by fresh air. To obtain a high temperature, the crucible *C* may be covered with char-



coal, but then a fragment of crucible must loosely cover the hole *t*, to keep out charcoal dust, &c.

If copper turnings are to be oxydized for the purpose of organic analyses, the crucible *C*, (fig. 2) is filled with the turnings; the crucible covered with a convex dish *u*, *u*, pierced with four or five little holes by the point of a nail, the crucible is luted to the dish, and then inverted on the grate of the furnace. By bringing the crucible to a dull red heat, the copper is rapidly oxydated.

These two examples are sufficient to show the uses of this new kind of muffle.

Ibid.

*New Apparatus for measuring very promptly the relative Refraction of Liquids.*

This apparatus is composed of a converging lens placed on a plate of glass with a space between the two to be filled by the liquid. A very simple formula gives the relative refraction of the liquid, after observing, 1st, the focus of the apparatus when water is interposed; 2nd, the focus when the water is replaced by the liquid in question. The instrument is destined principally to shew the chemical properties of liquids, and thus to serve in some measure as a re-agent in the laboratory. For example M. Guérin suspected that if two equally concentrated solutions of tartaric and paratartaric acid were subjected to examination, a difference of refractive power might be found between these two isomeric acids. The apparatus is simple and the calculation from the observed difference very easy.

L'Institute, No. 287.

*Leveling between the Black and Caspian Seas.*

M. Fuss in a note on the accumulation of errors in the final results of the geodesic levelling between the two seas, endeavoured to show that the method of observing two signals by placing one's self in the middle point of the space between them, can give accurate results only when care is taken to make daily but a finite series of observations and to alternate them in the same order as that in which they are made. He showed to what an extent errors might accumulate, for want of this precaution, in the definitive result of the levelling between these two seas, in which a difference of level has been found of 1045.2 English inches, a result which, by discarding doubtful observations, is reduced to 995.2 inches, while the method by corresponding observations furnished only 887.1 inches. But by applying to the first result the correction for the accumulation of errors arising from the neglect of the condition which ought to have been regarded in observing two signals from the middle of their distance, the amount was reduced to 902.5 inches, which differs from that obtained by corresponding observations only by 25.4 inches. When this correction is made, we may then seek by the calculation of probabilities the weight of these two results, and deduce from them the probable definitive value of the exact depression of the Caspian Sea.

Ibid.

*Formation of Silk.* By M. H. STRAUS—DURCKHEIM.

It is generally admitted by naturalists that the thread of the caterpillar is produced by a simple emission of liquid matter through the orifice of the

spinner, and that it acquires solidity at once from the drying influence of the air. It was easy to imagine such an hypothesis, for nothing more simple than the formation of a very fine thread by such a process. But a little reflection will soon show us, even *à priori* that it is not possible; for how can we comprehend that so fine a fibre, liquid at the instant of its issue from the aperture should immediately acquire such a consistence as to bear the weight of the animal suspended by it, and at the same time that it is rapidly produced. Though the fluid, holding the silk in solution, should be quickly volatilised, it must still be a matter of conjecture how the animal suspended by this thread could be able to arrest its issue, holding on only by the thread itself, for it cannot pinch the thread, seeing that it is only in a liquid state inside, and the thread cannot be glued to the edge of the opening, for its rapid adherence would prevent its issue while the animal is spinning. A little examination would satisfy us that silk cannot be produced in this manner, but that it is *secreted in the form of silk* in the silk vessels, and that the spinning apparatus only winds it. The thread is produced in the slender posterior part of the vessel, the inflated portion of which is the reservoir of ready formed silk, where it is found in the form of a skein, each thread being rolled up so as to occupy in the silk worm (*Bombex mori*) a space of only about a sixth part of the real length of the skein. The fact is shown by the following experiment which I made for the purpose of ascertaining whether the silk is formed in the body of the caterpillars.

Take one of the animals when about to form its cocoon, clean it in common vinegar, in which it may remain from four to six hours, open it on the back and extract the silk vessels, there being one on each side of the alimentary canal. Take them up by the hinder end, just where they begin to swell, (further back the silk is not solid enough) and draw them out. The membrane forming the vessel is easily torn open, and the contents expand to six or seven times its original length. The skein having attained its full length by the letting out of its gathers, we obtain a cord perfectly equal in size throughout, except at the end, where it is attenuated. This cord resembles a large horsehair, and constitutes what fishermen call *Florence hair*. I ought to add that in simply drawing out the silk vessel, the Florence hair is found enveloped in a golden-yellow gummy matter, forming the glutinous portion by which the worm fastens its thread. This must be got rid of by drawing the cord through the fold formed on the inside of the joint of the left fore finger, converted into a canal by applying to it the end of the thumb. The glutinous substance and the membranes being thus separated, we have the naked hair. In this state, before the silk becomes dry and hard, not only will it be indefinitely divided longitudinally, which proves its fibrous structure, but in trying to split it by drawing it transversely, the little filaments of silk which form it are perfectly separated, forming a bundle of extremely fine fibrils.

Ibid. No. 291.

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## Progress of Civil Engineering.

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### *Locomotive Excavator.*

M. Gervais, a manufacturer of Caen, and a member of the Superior Council of Commerce, has lately presented to the Academy of Science a small model of a locomotive excavator, (*Terassier Locomoteur*). This machine may be usefully employed in the excavation of canals and formation

of railroads; but from the want of strength in its construction, it seems at present suitable only to an alluvial soil. A force of steam of from two to three horse power is required to work it; it clears a space eight feet (2m. 50) wide, and 2 ft. 3 in. (0m. 70) deep, and advances 1 ft. 3 in. (0m. 38) a minute. Thus, in twenty-four hours it completes 1800 feet (547m. 20) in length; having cleared out 3250 feet (1000 cubic metres) of earth, which is levelled as regularly on each bank as it could be done by the hands of man. The expense in twenty-four hours cannot exceed 40 francs. The clearing of a cubic metre of earth, therefore, costs about 4 centimes. If we compare this with the price usually paid, the advantage of the invention is evident; but this is nothing in comparison with the advantages which we may expect to derive from the great saving of manual labour, and from the rapid increase of works so beneficial to the industry of the country.

The inventor's first idea was to employ men in levelling all occasional elevations beyond fifteen inches (0m. 40), but it was found less expensive to employ the machine used in cutting railroads. His plan proceeds on the same principle. The same frame which carries the locomotive, is arranged so that tools, attached to it, can work upwards from the surface of the earth, instead of downwards, and thus remove these elevations. A space is levelled equal in width to the working of the locomotive excavator, and then rails are laid down to preserve the direction and the level. The locomotive follows, excavating and throwing out the earth either on one or both of the banks, and forming an inclined plane, on each side, of forty-five degrees. If a canal is required to be sixteen feet (five metres) deep, or deeper, and cannot be excavated at once, there is attached to the machine behind, an axletree, and cast-iron wheels with large felloes, by which means, as fast as the first cutting is finished, lines are traced on which to place the rails for the second, and so as to preserve the original level. A machine capable of working twenty feet wide, and eight feet deep, excavates sixteen cubic feet of earth in a minute.

In railroads, the process would be nearly the same as in canals, except that the inclined plane on the sides need be only of fifteen degrees, and the earth might be carried away by carts wherever it was wanted. This machine is calculated for light and sandy soils; and is so constructed, that, should it encounter any obstacle, it may be stopped in a moment to prevent accidents. Thus, any rocky substance, if small, can be lifted up; if large, can be broken to pieces by the workmen, and carried away on the frame of the machine, after removing the tools, which can then be replaced, and the work continued.

It would be difficult to give a more particular detail without the aid of the plan, which the inventor has transmitted to the academy for the use of the committee, who, as well as ourselves, have seen the machine at work. Whatever their decision may be, it seems to us that the only question now, is the application of steam to the excavation of canals and railroads. The employment of this machine on a large scale, must be attended with great advantages, whether we consider the difficulty of collecting a considerable number of workmen on one spot, the increased rapidity of the work, or the improved salubrity of low grounds by the draining of marshes, and the removal of miasma and its consequent diseases. And these great advantages, if the machine of M. Gervais can really be employed on a large scale, are to be obtained at a remarkably small expense. Taking the model, which we have seen at work, as our data, if we calculate on a three horse power steam-engine, and a consumption of 15 kilogrammes (30 lbs.) of coal per hour, we



shall find, after deducting 30 per cent. interest for the outlay, and making every allowance for repairs, and loss of time when the machine is not at work, that it can excavate 957 cubic metres of earth at a cost of 48 francs 50 cents; whereas we now pay for excavating the same quantity, 478 francs 50 cents. In short, the invention of M. Gervais bids fair to make a great revolution in the mode of excavation, and we look forward with a degree of impatience for the decision of the committee of the academy.—*Inventors' Advocate.*

Mining Rev.

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*Description of a Machine called a Floating Clough. By GEORGE ELLIS, Grad. Inst. C. E.*

The machine here described is used for scouring a channel which leads from the Winestead Drainage and Haven of Patrington, into the river Humber. It is constructed in the following manner:—The frame is made of timbers six inches by four, twelve feet long, nine wide, and six deep. This frame is covered with planking two inches thick, and through the middle of it a culvert is formed with planks, two feet six inches in width, with a small lifting door at one end. Connected with the bottom and projecting in front are two long beams called feelers, which keep the machine in its course, and in the front are frames of wood shod with rough iron like the teeth of a saw, and these are connected with racks which can be raised by a lever.

At each side of the machine there is a wing which is made to fit the slope of the banks, to dress the mud from the sides, and to keep up the water behind the machine.

At high tide the machine is moored in the middle of the channel, the wings are extended and kept so by ropes, and when the tide is at half ebb the plugs are taken out, and the water rises about two feet in the machine, which causes it to sink; the plugs are replaced, and thus it remains till full ebb, when the iron-shod frames are let down in front, and the tide forces the whole machine, which is like a great dam, gently down the stream, scraping with it all the mud down to the river, where it is emptied, and floated back with the return tide. The whole distance, about three miles, is performed in two hours. A machine of the same kind is used with great advantage at Great Grimsby.

Proceed. Inst. Civil Eng.

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*Description of a Sawing Machine for cutting off Railway Bars. By JOSEPH GLYNN, M. Inst. C. E.*

The advantage of having the ends of the railway bars cut as nearly square as possible, that they may truly abut against each other, is so great, that many attempts have been made to effect it. The author in this communication describes the method which is adopted at the Butterly Works in the manufacture of the rails for the Midland Counties Railway. In general the ends, rough and ragged as they come from the rolls, are separately reheated and cut off by the circular saw, but the accuracy in this case depends on the workmen presenting the bar at right angles to the plane of the saw. As this cannot be insured, the difficulty may be obviated as follows. The axis of the saws and the bed of the machine, which is exactly like that of a slide lathe, are placed at right angles with the line of the rolls in which the rails are made; the saws are fixed in headstocks and slide upon the bed, so as to adjust them for cutting the rails to the exact length, and are three



feet in diameter and one-eighth of an inch thick, with teeth of the usual size in circular saws for wood, and make one thousand revolutions per minute; the teeth are in contact with the hot iron too short a period to receive any damage, but to prevent all risk the lower edge of the saw dips in a cup of water. The saw plate is secured between two discs of cast iron faced with copper and exposed only at the part necessary for cutting through the rail. The rail on leaving the rolls is hastily straightened with wooden mallets on a cast-iron plate, on which it lies right for sawing and sufficiently hot; thus a considerable saving of time, labour, and heat, is effected. The rail is brought into contact at the same time with the two saws, and both ends are cut off by one operation. If the saws be sharp and the iron hot, the seventy eight pound rails are cut through in twelve seconds. The rail on leaving the saws is placed in a groove planed in a thick cast-iron plate; thus all warping is prevented. The author then describes certain mechanical arrangements, which are exhibited in detail in the drawing accompanying the communication.

Ibid.

*On Framing Lock Gates without Iron Work. By S. BALLARD, A. Inst. C. E.*

The ledges, or horizontal pieces, are held to the back and mitre post by dovetail tenons and wedges; thus avoiding the use of iron T pieces and screw pins, which occasion the wood in immediate contact with them to decay, while the parts not pierced with iron are perfectly sound. This method was adopted in some gates on the Herefordshire and Gloucestershire canal, and after some years' experience, is found completely successful. Tar and white lead are put into the mortices, and the wedge driven down upon it, so that every crevice is filled, and the joints rendered water-tight; the planks, also, are fastened on with oak pins instead of nails.

Some discussion took place on the general opinion, that when dissimilar substances are in contact, as when a gate of one kind of wood is fastened with pins of another wood, some action tending to loosen the pins prematurely takes place betwixt them.

Ibid.

| LUNAR OCCULTATIONS FOR PHILADELPHIA,<br>MARCH, 1840. |      |      |                     |      | Angles reckoned to the right or<br>westward round the circle, as seen<br>in an inverting telescope.<br>☞ For direct vision add 180° ☜ |                        |
|------------------------------------------------------|------|------|---------------------|------|---------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Day.                                                 | H'r. | Min. | Star's name.        | Mag. | from Moon's<br>North point.                                                                                                           | from Moon's<br>Vertex. |
| 18                                                   | 9    | 24   | Im. $\chi$ Virginis | 6    | 337°                                                                                                                                  | 297°                   |
| 18                                                   | 9    | 39   | Em.                 |      | 311                                                                                                                                   | 272                    |

| Moon. | Days | Therm.       |           | Baromet.     |           | Wind.      |           | Water<br>fallen in<br>rain. | State of the weather, and<br>Remarks. |
|-------|------|--------------|-----------|--------------|-----------|------------|-----------|-----------------------------|---------------------------------------|
|       |      | Sun<br>rise. | 2<br>P.M. | Sun<br>rise. | 2<br>P.M. | Direction. | Force.    |                             |                                       |
|       |      |              |           | Inch's       | Inch's    |            |           | Inches.                     |                                       |
|       | 1    | 56           | 72        | 30.15        | 30.20     | N.E.       | Moderate. |                             | Lightly cloudy—clear.                 |
|       | 2    | 56           | 74        | .20          | .20       | W.         | do.       |                             | Clear—do.                             |
|       | 3    | 54           | 72        | .15          | .15       | N.E.       | do.       |                             | Clear—cloudy—aurora.                  |
|       | 4    | 62           | 69        | .04          | .00       | E.         | do.       | .40                         | Cloudy—rain.                          |
|       | 5    | 62           | 70        | 29.80        | 29.80     | W.         | do.       |                             | Cloudy—do.                            |
| ⊗     | 6    | 65           | 77        | .83          | .80       | S.W.       | do.       | .11                         | Cloudy—showery.                       |
|       | 7    | 66           | 76        | .75          | .75       | S.W.       | do.       |                             | Fog—cloudy                            |
|       | 8    | 70           | 72        | .65          | .60       | S.E.       | do.       | .24                         | Rain—do.                              |
|       | 9    | 72           | 82        | .65          | .64       | S.W.       | Brisk.    |                             | Cloudy—clear.                         |
|       | 10   | 66           | 74        | .75          | .75       | W.         | do.       |                             | Clear—do.                             |
|       | 11   | 64           | 67        | .83          | .83       | W.         | do.       |                             | Clear—do.                             |
|       | 12   | 56           | 67        | .90          | .90       | W.         | Calm.     |                             | Clear—flying clouds.                  |
|       | 13   | 53           | 67        | .90          | .93       | N.N.E.     | Moderate. |                             | Flying clouds—clear.                  |
| ☾     | 14   | 45           | 70        | 30.10        | 30.10     | W.         | do.       |                             | Clear—do.                             |
|       | 15   | 46           | 69        | .16          | .16       | W.         | do.       |                             | Clear—do.                             |
|       | 16   | 54           | 70        | .05          | .15       | S.W.       | do.       |                             | Fog—clear.                            |
|       | 17   | 54           | 74        | .03          | .00       | S.E.       | do.       |                             | Fog—flying clouds.                    |
|       | 18   | 65           | 73        | 29.75        | 29.70     | S.         | do.       | 1.00                        | Rain—thunder shower with hail.        |
|       | 19   | 58           | 72        | .80          | .83       | S.W.       | do.       |                             | Clear—do.                             |
|       | 20   | 56           | 75        | .90          | .95       | S.W.       | do.       |                             | Clear—do.                             |
|       | 21   | 60           | 77        | .90          | .95       | W.         | do.       |                             | Lightly cloudy—clear.                 |
| ☺     | 22   | 62           | 77        | .90          | .85       | W.         | Brisk.    |                             | Fog—clear.                            |
|       | 23   | 62           | 72        | .65          | .65       | W.         | Moderate. |                             | Clear—cloudy.                         |
|       | 24   | 55           | 71        | .65          | .95       | S.W.       | do.       |                             | Clear—do.                             |
|       | 25   | 55           | 72        | .65          | .55       | S.         | do.       | .9                          | Clear—rain.                           |
|       | 26   | 52           | 60        | .60          | .75       | S.W.       | Brisk.    |                             | Cloudy—clear.                         |
|       | 27   | 44           | 66        | .95          | .80       | W.         | do.       | .10                         | Clear—rain.                           |
| ☾     | 28   | 42           | 54        | .90          | .96       | W.         | Moderate. |                             | Clear—do.                             |
|       | 29   | 42           | 60        | 30.00        | 30.00     | W.         | do.       |                             | Lightly cloudy—clear.                 |
|       | 30   | 47           | 52        | .05          | .10       | N.E.       | do.       |                             | Cloudy—do.                            |
|       | Mean | 56.70        | 69.77     | 29.89        | 29.90     |            |           | 1.94                        |                                       |

|                                  |                     |                      |
|----------------------------------|---------------------|----------------------|
|                                  | Thermometer.        | Barometer.           |
| Maximum height during the month. | 82.00 on 9th.       | 30.20 on 1st. & 2nd. |
| Minimum " "                      | 42.00 23th. & 29th. | 29.55 25th.          |
| Mean                             | 63.235.             | 29.895               |

## OCTOBER 1839.

|      |       |       | Inch's | Inch's |          |           | Inches. |                           |
|------|-------|-------|--------|--------|----------|-----------|---------|---------------------------|
| 1    | 37    | 58    | 30.29  | 30.22  | N.W.     | Moderate. |         | Clear—do.                 |
| 2    | 41    | 62    | .20    | .05    | S.W.     | do.       |         | Clear—do.                 |
| 3    | 50    | 72    | 29.90  | 29.80  | S.W.     | do.       |         | Lightly cloudy—clear.     |
| 4    | 56    | 72    | .96    | .96    | N.W.     | do.       |         | Clear—do.                 |
| 5    | 46    | 57    | 30.29  | 30.30  | N.E.     | Brisk.    |         | Partially cloudy—clear.   |
| 6    | 44    | 60    | .44    | .48    | E.       | Calm.     |         | Clear—do.                 |
| 7    | 45    | 61    | .45    | .37    | N.W.     | do.       |         | Cloudy—do.                |
| 8    | 49    | 68    | .16    | .03    | N.W.     | do.       |         | Clear—do.                 |
| 9    | 51    | 71    | .30    | 29.95  | S.W.     | do.       |         | Lightly cloudy—hazy.      |
| 10   | 54    | 70    | 29.90  | .90    | S.W.     | do.       |         | Lightly cloudy—do.        |
| 11   | 51    | 66    | 0.10   | 30.00  | N.E.S.E. | do.       |         | Clear—do.                 |
| 12   | 56    | 59    | .03    | 29.95  | E.       | do.       | .14     | Cloudy—rain.              |
| 13   | 60    | 68    | 29.50  | .80    | S.       | do.       | .65     | Cloudy—rain with thunder. |
| 14   | 60    | 64    | .80    | .80    | N.E.     | Moderate. |         | Cloudy—do.                |
| 15   | 57    | 61    | 30.00  | 30.05  | N.E.     | do.       |         | Cloudy—do.                |
| 16   | 53    | 65    | .27    | .21    | W.E.     | do.       |         | Clear—do.                 |
| 17   | 51    | 68    | .20    | .20    | S.W.     | do.       |         | Cloudy—clear.             |
| 18   | 49    | 70    | .16    | .16    | W.E.     | do.       |         | Lightly cloudy—clear.     |
| 19   | 62    | 64    | 29.90  | 29.80  | E.N.E.   | do.       | 1 00    | Rain—drizzle.             |
| 20   | 42    | 48    | 30.15  | 30.30  | N.W.     | do.       |         | Clear—cloudy.             |
| 21   | 32    | 49    | .50    | .50    | N.W.     | do.       |         | Cloudy—clear.             |
| 22   | 40    | 56    | .01    | 29.90  | E.W.     | do.       |         | Hazy—do.                  |
| 23   | 42    | 62    | 29.85  | .71    | W.S.W.   | do.       |         | Hazy—do.                  |
| 24   | 50    | 71    | 30.02  | .35    | W.       | do.       |         | Hazy—do.                  |
| 25   | 52    | 65    | .07    | 30.06  | E.S.E.   | do.       |         | Fog—clear.                |
| 26   | 48    | 62    | .20    | .20    | E.S.     | do.       |         | Cloudy—clear.             |
| 27   | 51    | 65    | .10    | .05    | W.S.     | do.       |         | Cloudy—clear.             |
| 28   | 63    | 67    | 29.90  | 29.85  | W.S.     | do.       |         | Cloudy—do.                |
| 29   | 46    | 60    | .90    | .91    | W.       | do.       |         | Clear—do.                 |
| 30   | 41    | 60    | .90    | .90    | W.       | do.       | .25     | Clear—cloudy—rain.        |
| 31   | 43    | 56    | .63    | .66    | W.       | Calm.     |         | Clear—flying clouds.      |
| Mean | 49.10 | 63.13 | 30.06  | 30.03  |          |           | 2.64    |                           |

|                                  | Thermometer.         | Barometer.     |
|----------------------------------|----------------------|----------------|
| Maximum height during the month. | 72.00 on 3rd & 11th. | 30.60 on 21st. |
| Minimum " "                      | 32.01 21st.          | 29.63 31st.    |
| Mean,                            | 56.115               | 31.045         |

### Hygrometer.

JULY, 1839.

| County.           | Town.          | Observer.             | 7     | 8     | 9     | M     | M     | D     | I  | J     | Day   | 7     | 8     | 9     | M     | N     | N     | D     | C   | C   | I   | R    | S    | R    | S       | Th    | R | N  | N  | N | E  | E  | S  | S  | S   | S   | W  | W   | N   | N  | C    | D     | D     | D     | W     | P     | N     |       |      |     |
|-------------------|----------------|-----------------------|-------|-------|-------|-------|-------|-------|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|-----|-----|------|------|------|---------|-------|---|----|----|---|----|----|----|----|-----|-----|----|-----|-----|----|------|-------|-------|-------|-------|-------|-------|-------|------|-----|
| 1 Philadelphia,   |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 2 Montgomery,     | Newtown, .     | L. H. Parsons. .      |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 3 Bucks, .        |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 4 Lehigh, .       |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 5 Northampton,    | Stroudsburg,   | A. M. Stokes. .       | 65.39 | 83.93 | 69.26 | 91.   | 56.   | 72.86 | .  | ..... | ..... | 29.34 | 29.31 | 29.30 | 29.75 | 29.   | 29.32 | .     | 9   | 21  | 1   | 7    | .... | .... | 42.670  | 4½    | . | ½  | .  | . | .  | 1½ | .  | 1½ | .   | 7½  | 2½ | 8   | 1½  | 3½ | .    | .     | ....  | .     | ....  | 65.85 | 11    | 788   |      |     |
| 6 Monroe, .       |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 7 Pike, .         |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 8 Wayne, .        |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 9 Susquehanna,    | Silver Lake,   | E. Rose. .            | 66.48 | 74.84 | 76.81 | 86.   | 57.   | 70.70 | .  | 52.   | 63.58 | 28.07 | 28.07 | 28.04 | 28.30 | 27.85 | 28.06 | .     | 12  | 19  | .   | 5    | .... | .... | 2.220   | .     | . | .  | .  | . | .  | .  | 5½ | ¾  | 15½ | 1   | 3½ | .   | 4½  | .  | .... | .     | ....  | .     | ....  | 65.85 | 11    | 788   |      |     |
| 10 Luzerne, .     |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 11 Schuylkill,    | Pottsville, .  | John Porter. .        | 67.68 | 78.31 | 68.32 | 87.   | 59.   | 71.44 | .  | 45.   | 57.65 | 29.17 | 29.15 | 29.17 | 29.88 | 28.86 | 29.16 | .     | 15½ | 15½ | .   | 12   | .... | .... | 6.995   | 1½    | . | ½  | .  | . | .  | 1  | .  | .  | 4½  | .   | 8  | 6½  | .   | 9½ | .    | ....  | .     | ....  | .     | ....  | 784   |       |      |     |
| 12 Berks, .       | Reading, .     | C. F. Egelman. .      | 71.77 | 78.35 | 67.45 | 87.   | 59.   | 72.52 | .  | ..... | ..... | 29.73 | 29.67 | 29.67 | 30.   | 29.47 | 29.69 | .     | 10½ | 14½ | .   | 9    | .... | .... | 64.999  | .     | . | .  | .  | . | .  | 1½ | .  | 9  | 10  | ¾   | 4  | 2   | 11½ | .  | 1    | .     | ....  | .     | ....  | .     | ....  | 785   |      |     |
| 13 Lancaster,     | Haverford, .   | Haverford School.     | 71.00 | 79.76 | 71.53 | 86.   | 58.   | 74.11 | 3½ | 57.   | 66.61 | 29.55 | 29.54 | 29.56 | 29.86 | 29.19 | 29.55 | 4     | 11  | 15½ | 4½  | 15   | .... | .... | 13.743  | .     | . | 2  | .  | ½ | .  | 2  | ¾  | 6  | .   | 8   | ¾  | 10½ | .   | ½  | 2    | 65.63 | 1     | ....  | .     | ....  | 789   |       |      |     |
| 14 York, .        | Lancaster, .   | Conservatory of Arts, | 69.61 | 81.30 | 71.14 | 91.   | 61.   | 74.03 | .  | 56.   | 66.24 | 29.49 | 29.48 | 29.48 | 29.75 | 29.16 | 29.48 | .     | 14½ | 13  | 3½  | 12   | .... | .... | 42.608  | 3     | . | 1  | .  | ½ | .  | 1½ | .  | 6  | 2½  | 5   | 1  | 2½  | ¾   | 6  | 1    | .     | 56.69 | .     | ....  | 70.85 | .     | ....  | 815  |     |
| 15 York, .        | Yurk, .        | Calvin Mason.         | 77.71 | 82.06 | 73.08 | 90.   | 63.   | 77.62 | .  | 56.   | 65.39 | 29.53 | 29.53 | 29.54 | 29.80 | 29.30 | 29.53 | .     | .   | .   | .   | 6    | .... | .... | 12.361  | ½     | . | ½  | .  | ¾ | .  | ½  | .  | .  | 2½  | .   | 3  | ¾   | 2½  | 1  | .    | 52.34 | .     | ....  | .     | ....  | .     | ....  | 811  |     |
| 17 Lebanon, .     |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 18 Dauphin, .     |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 19 Northumberland | Northumberland | Andrew C. Huston.     | 69.48 | 78.79 | 70.05 | 85.   | 56.   | 72.77 | .  | 50.   | 61.26 | 29.43 | 29.41 | 29.41 | 29.71 | 29.10 | 29.42 | .     | 9   | 22  | .   | 10   | .... | .... | 47.337  | 3½    | . | ½  | .  | ½ | .  | 2  | ¾  | 8  | .   | ½   | ½  | 3   | ¾   | ½  | 8½   | .     | ....  | .     | ....  | 69.66 | .     | ....  | 783  |     |
| 20 Columbia, .    |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 21 Bradford, .    |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 22 Tioga, .       |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 23 Lycoming, .    |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 24 Union, .       |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 25 Mifflin, .     | Lewistown, .   | J. Culbertson, M. D.  | 73.10 | 77.93 | 75.26 | 86.   | 67.   | 75.43 | .  | ....  | ....  | 29.38 | 29.27 | 29.24 | 29.53 | 28.49 | 29.26 | .     | 9½  | 8½  | 12½ | .... | .... | .... | ....    | .     | . | 4  | .  | ½ | .  | 1  | .  | ½  | .   | 18½ | 2  | ½   | ½   | 3½ | ¾    | .     | ....  | .     | ....  | .     | ....  | 794   |      |     |
| 26 Juniata, .     | Mifflintown, . | J. S. Kinkadee.       | 70.74 | 77.85 | 73.24 | 85.50 | 62.   | 78.94 | 1  | ....  | ....  | 29.46 | 29.45 | 29.41 | 29.71 | 29.11 | 29.44 | 6     | 6   | 14  | 11  | 6    | .... | .... | 34.280  | .     | . | 1½ | .  | . | .  | 2½ | .  | 5½ | .   | 1   | .  | 5   | ½   | 11 | 5    | ....  | .     | ....  | .     | ....  | 779   |       |      |     |
| 27 Perry, .       |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 28 Cumberland, .  | Carlisle,      | Prof. W. H. Allen.    |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 29 Adams, .       | Gettysburgh,   | Prof. M. Jacoba.      | 68.78 | 80.41 | 70.00 | 87.50 | 59.50 | 73.06 | .  | 52.50 | 62.33 | 29.40 | 29.37 | 29.39 | 29.68 | 29.08 | 29.39 | .     | 15½ | 15½ | .   | 3    | .... | .... | 124.517 | 2½    | 1 | .  | .  | . | .  | ½  | .  | 4½ | 2½  | 5½  | 1½ | 3½  | 1   | 2½ | 2½   | 3     | .     | 63.02 | .     | ....  | 71.91 | .     | .... | 786 |
| 30 Franklin, .    | Chambersburg,  | Alex Thompson, Jr.    | 71.57 | 83.90 | 72.13 | 91.   | 63.   | 75.80 | 8½ | ....  | ....  | 29.29 | 29.27 | 29.27 | 29.61 | 29.01 | 29.08 | 8½    | 9   | 18½ | 8½  | .... | .... | .... | ....    | .     | . | .  | .  | . | .  | 1½ | .  | .  | 9½  | .   | 1½ | 2½  | .   | 1½ | 15   | 64.50 | 9     | ....  | 70.09 | 10    | 780   |       |      |     |
| 31 Huntingdon, .  |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 32 Centre, .      | Bellefonte, .  | John Harris. .        | 66.13 | 80.08 | 67.63 | 91.   | 46.   | 71.28 | 2  | 40.   | 55.96 | 7     | 29.23 | 29.22 | 29.23 | 29.51 | 28.94 | 29.23 | 2   | 9½  | 19½ | 2    | .... | .... | ....    | 5.755 | 3 | .  | 2½ | . | .  | .  | 2  | ¾  | 9½  | ¾   | 5½ | .   | 4   | ¾  | .    | 2     | ....  | .     | ....  | .     | ....  | 831   |      |     |
| 33 Potter, .      |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 34 McKean, .      | Smithport, .   | Richard Chadwick.     | 61.77 | 76.89 | 61.08 | 92.   | 50.   | 66.58 | 4½ | 40.   | 54.50 | 5     | 28.26 | 28.25 | 28.25 | 28.48 | 28.02 | 28.05 | 4½  | 8½  | 18  | 4½   | 19   | .... | ....    | 7.372 | ½ | .  | ½  | . | 2½ | .  | 1½ | .  | ¾   | .   | 3  | .   | 14  | .  | ¾    | .     | 3     | 4½    | 72.06 | 16    | ....  | 73.72 | 6    | 798 |
| 35 Clearfield, .  |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 36 Cambria, .     |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 37 Bedford, .     |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 38 Somerset, .    |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |
| 39 Indiana, .     |                |                       |       |       |       |       |       |       |    |       |       |       |       |       |       |       |       |       |     |     |     |      |      |      |         |       |   |    |    |   |    |    |    |    |     |     |    |     |     |    |      |       |       |       |       |       |       |       |      |     |

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**JOURNAL**  
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**State of Pennsylvania,**  
AND  
**MECHANICS' REGISTER.**

FEBRUARY, 1840.

**Practical and Theoretical Mechanics and Chemistry.**

*History of the Steam Engine, with a reply to the Criticisms to which the first publication of the article gave rise.* By M. ARAGO.

[From the Annual of the Board of Longitude, for 1836.]

TRANSLATED BY LIEUT. A. A. HARWOOD, U. S. N.

[CONTINUED FROM PAGE 20.]

1769. *James Watt.\**

Before commencing the review of Watt's invention, I ought, perhaps, to transcribe here the titles of the various patents which he obtained during his long and glorious career. The reading of these titles would shew clearly the object of the important improvements which this illustrious machinist introduced successively in the machines of his predecessors; it would un-

\* James Watt was born at Greenock, in Scotland, in the year 1736, of poor but respectable parents. The extreme weakness of his constitution did not seem to promise him a long life. This unfortunate circumstance at least developed in him at an early period, habits of retirement and application without which much is rarely accomplished. Young Watt attended one of the public free schools, called, in Scotland, *grammar schools*, until his sixteenth year, afterwards his parents got him an apprenticeship in a small workshop where they made compasses, scales, some kinds of philosophical apparatus, quadrants, and various implem<sup>t</sup>s used in fishing: he remained there four years. Finally Watt went to London and lived with a mathematical instrument maker. There a particular piece of work occupied him near the door of the workshop the whole of a winter's-day, and he was seized with a violent cold of which the physicians could not cure him perfectly. He then resolved to try the effect of his native air, returned to Scotland and there set up a modest establishment on his own account. In the year 1757 the University of Glasgow appointed Watt, then 21 years of age, keeper of its collection of models. With this title he received accommodations

deceive those, on the other hand, who believe, without any foundation, that the steam engine now in use was contrived at once, and by one person; but the necessity of abridging this memoir obliges me to enter at once into the subject in hand.

### *Of the Condenser.*

That the atmospheric engine, or *Newcomen's engine*, should produce any serviceable effect, it is necessary, in the first place, that at the instant when the descending movement of the piston begins; there shall be a vacuum below

in the college, with permission to continue his employment there. Robison was among the students of the University. He became intimate with Watt, confided to him the plan which he had conceived of applying the steam engine to locomotion, and engaged him to interest himself in bringing it to perfection. Some experiments made by the artists in 1759, 1761, and in 1762, led to no result: but in 1764 some new attempts were quite successful. Employed as a mere workman to repair one of Newcomen's engines which belonged to the philosophical apparatus of the University, Watt discovered defects in it which the smallness of the model rendered more apparent; but which would also have existed in large machines. Such is the date and origin of the improvements explained in the text. Many years, however, glided away before Watt could submit them to a decisive proof. In 1764, he quitted the University after getting married, and was employed for some time as a surveyor. His first improved machine was not finished until 1768; it was on a tolerably large scale, for the cylinder was eighteen English inches in diameter. Dr. Roebuck who, by his pecuniary advances, had furnished Watt with the means of completing his work, caused the new machine to be established at Kinneal on the shaft of a coal mine belonging to the Duke of Hamilton. All these names appear to me worthy of being preserved; they belong to history. In this same year, 1768, Watt solicited his first patent; he did not obtain it, however, until 1769. At last Matthew Boulton, of Birmingham, became his associate in 1773, after the voluntary withdrawal of Dr. Roebuck. The fortune of this manufacturer, the capacity and activity of his mind, the personal relations which he had contracted with a multitude of individuals belonging to all classes of society gave the liveliest impulse to the enterprise. The privilege granted by the patent was about to expire, however, before the new manufactory of Soho had yielded any real profit. Boulton made application to the authorities, solicited the co-operation of his numerous friends, interested the court and the city in his plans, and by his numerous and judicious proceedings obtained, of Parliament, the extension of the original privilege until the year 1800. Beginning from this period (1775) the association of Watt and Boulton prospered in the highest degree. The sterile hill of Soho, near Birmingham, where the eye of the traveller hardly discovered the hut of a game keeper, was covered with beautiful gardens, sumptuous habitations, and with workshops which both from their extent, and from the importance and perfection of the works executed in them, became in a short time the first in Europe. The discoveries of Watt were of too immediate and popular application to render academic titles any accession to the renown of this great mechanician. We may remark, however, that the principal learned societies, those of Edinburgh and London for instance, hastened to admit him as a member. The Institute of France elected him a correspondent in 1808; and in 1814 bestowed upon him the highest reward in its power, by nominating him one of its *eight* foreign associates. Having attained an advanced age, possessor of a brilliant fortune, the fruit of his noble and laborious works, enjoying the respect and esteem of the whole world, Watt gave up his commercial affairs and retired to Heathfield his country seat near Birmingham. There, the patriarch of British industry, always benevolent, modest and reserved, as when in his youth he kept the apparatus of the University in order, his days glided on peaceably in the society of a small circle of friends. In 1807 Watt made a journey to Scotland. Upon his return his health was much enfeebled. At length he died on the 25th of August 1819 after a short illness, at the age of 84 years. A statue is about to be erected to Watt, in one of the squares of Birmingham at the public expense. The most distinguished portion of the English community have shown an honorable eagerness to enroll themselves among the subscribers.

it; secondly, that during the ascending motion, the steam which issues from the boiler into the cylinder shall not lose any of the elastic power which it had acquired at the expense of a considerable quantity of fuel.

The first condition requires that at the instant condensation takes place, the water which is injected should cool the sides of the cylinder; otherwise the steam to be condensed would retain a good deal of its elasticity and would oppose a serious obstacle to the descending motion of the piston produced by the atmospheric pressure. The second condition exacts, on the contrary, that the sides of the cylinder should be very hot. In fact, steam at a temperature of  $212^{\circ}$  Fab. does not retain its proper elastic power in entering a vessel unless the sides of the vessel are themselves heated to  $212^{\circ}$ . If the temperature of the sides be less, the current of steam soon loses its original heat, and more or less of the elastic force which it possessed. Thus during the descending movement of the piston, the sides of the metallic cylinder in which it works ought to be as cold as possible, if the condensation is to take place in this cylinder; during the ascending movement, on the contrary, the sides should be at  $212^{\circ}$ . The cooling is effected by projecting water not only in the midst of the steam but also on the inner surface of the cylinder. As to the heating of the cylinder which ought to follow this operation, the question is how is it to be duly effected? The steam will, of itself, produce the desired heat after a time; but it will be but slowly, and for this reason the ascending movement of the piston being very slow, the engine will not perform in twenty-four hours the work which without this sort of impediment, might have been calculated upon. We may also remark, that the steam proceeding from the boiler does not heat the cylinder without some loss of its own heat, in other words, without being condensed; but steam is costly (even though the water from which it is generated cost nothing,) on account of the fuel used in its production. That there may be no doubt of the attention which should be paid to this consideration, I will observe that the quantity of steam employed to heat the sides of the cylinder would fill the interior space many times, so that the expense of steam, or that which is the same, the expense of fuel, in short the actual outlay of money necessary for setting the engine in motion would be *many times* less, if the necessity for the successive heatings and coolings of which we have just spoken could be done away with. Such is precisely the problem which Watt solved by a method which allows the cylinder always to remain at  $212^{\circ}$ . For this purpose he found it necessary:—

*To effect the condensation of the steam in a separate vessel, entirely distinct from the cylinder, and only communicating with it by a straight tube.*

Let us explain this ingenious process, which will always constitute Watt's principal claim to the gratitude of posterity.

If a free communication be made between a cylinder filled with steam, and a vessel void both of steam and air, the steam in the cylinder will pass partially and very rapidly into the vessel, and the rush will not cease until the elasticity becomes equal throughout. Suppose the vessel to be kept cool inside and out by means of an abundant and continual injection of water; then all the steam with which the cylinder was originally filled will pass in and be condensed successively; the cylinder will, in this way, be cleared of steam without its sides becoming cooled, and the new supply of steam with which it may be necessary to fill it a moment afterwards, will not lose any portion of its elasticity.

A vessel thus separated from a cylinder, and into which the steam of the



cylinder occasionally passes, is called a *condenser*. This is the most important part of Watt's engine.

The operation of the *condenser* which has just been explained, was due to two circumstances, first to its containing cold water, and second that the remaining space inside of it was void of elastic fluid.\* After the condensation of steam has taken place, these two causes of success disappear; the condensing water becomes heated by absorbing all the caloric contained in the steam, a considerable quantity of vapour is generated at the expense of this hot water; finally the cold water contains atmospheric air, which is disengaged as it becomes heated. If, after each operation, the water, steam, and air contained, be not removed from the condenser it will cease to produce its effect. Watt removed them by means of an ordinary pump called an *air pump*, the piston of which was connected with the working beam of the engine. When the effect of one of Watt's engines is calculated, it is necessary then to take into account the portion of power used to keep the air pump in operation. This deduction, however, is but a trifling matter compared with the loss which the condensation of steam upon the cooled sides of the cylinder produced in the old method.†

### *Double Acting Engine.*

The atmospheric engine, whether the injection of cold water operates in the middle of the cylinder or in a separate condenser, has no real power except during the descending stroke of the piston. It is then, and then only, that the weight of the atmosphere produces its effect. During the ascending movement this weight is counterbalanced by the pressure of steam which forces the piston from below upwards. The motion is then determined solely by a counterpoise which hardly exceeds the weight of the piston, making up for the friction which the latter encounters from the sides of the cylinder. This is not an inconvenience when the engine is employed in pumping up water from mines. The descending stroke of the piston determines, in fact, a corresponding motion in the extremity of the working beam with which it is connected, and hence an *ascending* motion at the other extremity. During this motion the water situated vertically under the last

\* Strictly speaking, a vessel is never entirely free from elastic fluid as long as it contains water, for vapour is disengaged from the coldest water; but when the injected fluid is of no higher temperature than the ordinary temperature of the atmosphere, we may disregard, in practice, the vapour which rises from it.

† The brief remarks which follow will lead to an exact idea of the commercial importance of the invention of the condenser. To grant permission to substitute their machines for Newcomen's, Watt and Boulton exacted the value of *one-third of the quantity of coal saved by each new engine of the same power*. A preliminary experiment made upon two engines of either kind, of precisely the same dimensions, showed the amount of the saving, for example upon a thousand strokes of the piston. A simple proportional calculation decided afterwards the tax to be received as soon as they ascertained the number of strokes which the engine used made monthly. Watt and Boulton determined this number by means of a piece of clock work attached to the piston, and so arranged that each stroke would advance the hand one division. This piece of mechanism, or counter, was enclosed in a box having two keys, which was opened upon every settlement of accounts in presence of an agent of the inventor, and of the director of the mine. In the Chatwater mine in Cornwall, where three engines were in operation, the proprietors bought the right from the inventors for an annual sum of \$12,000, which proves that the substitution of the *condenser* for the injection which, before that invention, took place in the cylinder, had there caused a saving of fuel of more than \$36,000 annually.

mentioned extremity of the beam, is raised by a quantity equal to the descent of the piston in the cylinder. When the piston of the pump descends there is no manner of use in accelerating the motion, and any power employed for that purpose would be entirely wasted. The operation is analogous to that of drawing water from a well; we let the bucket go down by its own weight without ever imagining a necessity for employing a motive power for that purpose. Thus for the purposes of draining, the atmospheric engine is perfect, and its intervals of action do not make it defective; it is not so, however, when this species of engine is used as a motive power for machinery. The machinery in that case must be in rapid action while the piston is descending; but during the ascending stroke must either stop or only continue in motion in virtue of the velocity previously acquired. An engine therefore which would retain its power during the *two* opposite motions of the piston would present real advantages. Such is the object of the engine invented by Watt which is called the *double acting engine*.

The atmosphere has no part in the action of this engine. The cylinder is closed at the top by a metallic cover, with a hole in the centre well packed with greased hemp, to allow the free action of the piston rod without giving vent to the steam. In this way the piston divides the cylinder into two tight and distinct spaces. When it descends the steam comes freely into the upper space through a tube suitably placed for this purpose, and impels the piston from above downwards, as the pressure of the atmosphere operated in the atmospheric engine. This motion meets with no obstacle provided that during its continuance the lower part of the cylinder, and the lower part alone, is in communication with the condenser. As soon as the piston is entirely down, matters are completely reversed by the simple movement of two valves. Then the steam which the boiler supplies passes below the piston, which rises, and the steam above it which a moment before produced the descending motion, rushes into the condenser, with which it is in turn in free communication, and is condensed. A contrary arrangement of the same valves restores every thing to its original state as soon as the piston has gained the extremity of its stroke. The engine goes on in this way, indefinitely, with nearly the same power whether the piston ascends or descends; but it is worth remarking that the expense of the steam is double that in an atmospheric, or single, acting engine.\*

### *Engines using Steam Expansively.*

In the double acting engine of which I have just spoken, the piston is alternately impelled by the steam from above downward and from below upward. If the boiler is in free communication with the cylinder *during the whole time* required by each of these oscillations, the piston will be subjected

\* Papin, as I have before observed, foresaw in 1695 that steam engines would not always be exclusively employed for draining mines. At this period he had already indicated a method for connecting the piston rod with a revolving wheel, and for changing the reciprocating rectilinear motion of the piston into the rotary motion of the wheel. The want of continuity in the action of the atmospheric engine also attracted his attention. To prevent his wheel from having a jerking motion, he proposed to connect it with two or more pistons belonging to distinct cylinders, and so arranged, where there were two, for instance, that the one should descend while the other was rising and reciprocally. Two cylinders of atmospheric engines thus combined would produce exactly the effect of Watt's engines. The expense of steam would also be precisely the same. The idea of making a double acting engine by means of two distinct cylinders, was presented as new, in 1779, by Doctor Talck.



to the action of a constant force, it will, therefore, be accelerated in its motion towards either extremity of the cylinder in which it works, and this without producing any useful effect will tend to jar the whole apparatus. If, on the contrary, the valves adapted to the two tubes which establish the communication between the boiler and the cylinder do not remain open during the whole of the stroke of the piston; if they are closed for instance, in turn, when the piston has reached two thirds of the stroke, the remaining third will be accomplished by the momentum already acquired, and by the power which the steam already introduced will then continue to exert. This force will become less and less during this last third of the course of the piston, because the steam will gradually expand, and in proportion as it occupies a larger space, its elasticity, like that of every elastic fluid, will diminish. Thus, there will be no injurious rapidity of motion at the two extremities of the stroke, and, what is still more important, a smaller quantity of steam will be employed to produce the desired motion. Who does not see in fact, that, if the valve were open during the whole stroke of the piston, the condensation would destroy at every stroke a volume of steam equal to that of the cylinder, and of a density similar to that of the steam of the boiler, while that if the valve is closed when the piston is at two thirds of its stroke, one third less steam will enter and be consumed. Experiments have shown that in thus using a cut-off valve to regulate the quantity of steam admitted to the cylinder, a considerable quantity of fuel may be saved, while the same effect is produced; therefore they rank the specification which Watt inserted in relation to it in his first patent among the most brilliant of the inventions for which science is indebted to him; it does not appear, however, that in the greater part of the engines obtained from the manufactories of Soho, the cut-off principle has been employed to any considerable extent, but it has rather been resorted to to render the motion of the piston nearly uniform.

#### *Jacket for the Cylinder.*

The *separate condenser*, the most beautiful of Watt's inventions, is intended, as we have already seen, to keep the cylinder constantly at the same temperature as that of the steam, so that it may not partially condense when it is admitted from the boiler. But the whole exterior surface of the cylinder is in contact with the atmosphere, and therefore continually exposed to its cooling action, and by the conducting power of the cylinder for heat, the steam must be exposed to this same cooling action. Watt proposed to diminish this effect by surrounding the cylinder with a second one. A casing of this kind, if closed above and below, would prevent the action of cooling draughts of air, and this alone would be an important advantage gained. But besides this, steam can be introduced into the annular space comprised between the two cylinders, and then the temperature of the cylinder proper will differ so little from that of the steam supplied by the boiler, that, practically, they may be considered as perfectly alike.

#### *High Pressure Engines.*

The engines of which we have hitherto spoken do not require that the steam which sets them in motion should operate with a greater pressure than that of the atmosphere. To get rid of the steam after its action it is sufficient to condense it. This operation requires a copious supply of cold water, which in many situations is a serious inconvenience. Locomotive engines, such as will answer for drawing cars upon railroads, cannot be constructed upon this principle. They would, in fact, be required not only to carry

with them a sufficient quantity of fuel to supply the furnace, and water to replace that from the boiler, which is gradually converted into steam, but also an enormous quantity of cold water for the process of condensation. Such a machine would not be capable of doing much work; and would, in fact, be hardly powerful enough to impel itself. The necessity for avoiding the use of the condenser gives a high value to high pressure engines.

In these engines, when the steam has driven the piston upward, the opening of a valve allows it to escape into the air. The difference of elasticity regulates this escape; it ceases therefore as soon as the pressure of steam within ceases to exceed that of the atmosphere. Thus, there is not a vacuum in the cylinder, as in the condensing engine. The steam then, which, after the upward motion of the piston, is to drive it downwards, must overcome a resistance equal to the atmospheric pressure before it can produce any useful effect. The same remark applies to the ascending motion, for at the instant in which it takes place, the upper part of the cylinder contains steam, and thus in succession.

Papin first constructed an engine in which high pressure steam escaped after having produced its effect. This engine was exclusively designed for raising water. Leupold who made it known, described one of the same kind in 1724, in his *Theatrum machin. hydraul.* This had a piston and working-beam, but was single acting.

Finally,\* in 1802, Messrs. Trevithick and Vivian, took out a patent in England, for a double acting high pressure engine, which has been applied by them, or others, to propelling carriages upon rail-roads. Watt, in his first patent of 1769, had already reserved to himself the right, in case cold water should be scarce, to make engines go entirely by means of steam, which might be allowed to pass off into the air after it had produced its effect; but it does not appear that any engine was ever constructed upon this principle in his manufactory.

### *High Pressure Condensing Engines.*

These are high pressure engines, in which the steam is condensed after it has acted, as in low pressure engines. The most esteemed engines of this kind are those suggested by Mr. Arthur Woolf, in 1804; but they cannot be applied to locomotive purposes. In the engines of this engineer, highly elastic steam coming directly from the boiler, passes into the cylinder as in a double acting engine. The steam is not, however, condensed as soon as it has propelled the piston to one extremity of its stroke. Mr. Woolf makes the most of it, before its condensation, in the following manner.

By the side of the first cylinder, there is another of nearly the same height, but of greater diameter. The upper part of the first communicates by a tube with the lower part of the second, and reciprocally. When the steam has propelled the piston of the first cylinder to the lower part of its

\* The American reader will be surprised, and perhaps shocked, that an article on the high pressure steam engine should close without a mention of the name of Oliver Evans, who laboured so long to bring it into use, and died in poverty from the expenditures encountered in this his favorite object. In 1801, he had a high pressure engine at work in Philadelphia. His drawings were sent to England in 1794-5, and so nearly does the patented boiler of Trevithick resemble his, that the charge of plagiarism has been unhesitatingly preferred by American writers. But of all this, M. Arago appears to know nothing. A distant continent subtends a less angle to his mental vision than a near Island. Happily, as he says himself, the argument from Arithmetic is incontrovertible, and 1801 precedes 1802.

stroke, at the precise moment in which the same piston begins to ascend by the action of a new supply of steam from the boiler, which impels it from *below upward*, all the steam with which the smaller cylinder is filled, and which has already given impulse to the first descending motion, flows into the second cylinder below its piston, and impels it also from *below upwards*. Thus, the two pistons move in the same direction. As soon as the motion is completed, the dilated steam which occupies the whole body of the larger cylinder passes into, and is condensed in a detached condenser. A new supply of steam coming from the boiler is then admitted *above* the first cylinder, and impels its piston from *above downwards*. The old steam with which the whole of the lower part of this cylinder was filled at the conclusion of the first motion, passes, and expands, *above* the piston of the second cylinder, and forces it *down*, so that the two pistons again work in the same direction. If each piston is provided with a vertical rod, and if the two rods are attached to two points of the working beam situated on the same side of its centre of rotation, the vibrations of the beam take place in virtue of the *united impulses of the two pistons*; the same steam therefore will have produced two effects before being condensed.

This engine of Woolf is a genuine expansive engine, resembling very much that described by Mr. Hornblower in his patent of 1781. It is not apparent *à priori*, why cutting off the steam should not produce, in the mode of working proposed by Watt, in a single cylinder, as much effect as in following Woolf's system.\* The experiments published in the monthly reports of the mines of Cornwall, appear, it is true, very favourable to this system, but they will not receive a general assent until comparisons are made with engines alike in all other respects, save in the manner of using the steam expansively.

#### Steam Vessels.

The application of the steam engine to navigation has, in certain countries, as in America for example, produced more important results than any other modern invention. The question of priority has therefore been the object of warm controversy. From the beginning the claims of France have been left out of the question, and the debate seems to have rested entirely between the English and the Americans. The latter attribute the application to Fulton. The English refer to the much earlier writings of Jonathan Hull and Patrick Miller. The argument is indisputably against Fulton;† but are there no works still older than Jonathan Hull's, and in which the ideas of this mechanician may be found already embodied? The reader will decide whether my researches upon this point have been unsuccessful. Jonathan Hull's work appeared in 1737. Here is the translation of the title, "Des-

\* M. Arago appears to have overlooked here the effect of the cooling of the cylinder in which the expansion of the steam takes place in the common engine, requiring it to be again heated to the temperature of the steam in the boiler.—TRANS

† The argument is as decidedly against Fulton as against the claims advanced by M. Arago in favour of Papin, or Solomon de Caus, in relation to the application of steam as a motive power, in opposition to those of Hero of Alexandria. The Americans claim for Fulton the first *successful* application of steam to navigation, and this cannot fairly be refused to him. A steamboat constructed under Fulton's directions plied regularly on the Hudson when there was no other steamboat running upon any other waters in the world. This fact cannot be impugned. The attempts made in France, England and Scotland, were *unsuccessful*, and the boats were subsequently laid up. Fulton's attempt succeeded, and since that time the application of steam to navigation has been steadily on the increase. The problem was solved.—TRANS.



cription and draught of a newly invented machine for carrying vessels or ships out or into any harbour, port, or river, against wind or tide, or in a calm; on account of which his Majesty, George II, has granted letters patent for the profit of the author for fourteen years; by Jonathan Hull."

This work includes, in the first place, the figure and description of two paddle wheels placed at the stern of the vessel, which the author proposes to substitute for common oars; secondly, the proposition to turn the axis of these wheels by means of Newcomen's engine, then well known, but only used, according to Hull's own expression, to raise water by fire.

Patrick Miller's work appeared in Edinburgh in 1787, it contains also a description of paddle wheels,\* considered as the means of propelling canal boats, and the notes of the author's experiments upon the most convenient method of making these wheels revolve. The last article concludes with the following remark: "I have some reasons to think that the power of the steam machine may be employed to turn wheels in a way to give them a quicker motion, and consequently to increase the speed of the boat."

Here is every thing of a precise character, or remote date, which the English critics have quoted in their controversy with their American opponents.† I shall now proceed to furnish my quota.

Papin's work which I have so frequently cited, the *Recueil* of 1695, comprises literally what follows, pages 57, 58, 59, and 60.

"It would be tedious to relate here in what manner this invention (that of the atmospheric engine) might be applied to draining mines, to *throwing bombs, to rowing against the wind*. . . . I cannot, however, refrain from remarking how preferable this power would be, for ensuring speed at sea, to that of the galley slaves." Here follows his remarks upon living prime movers, which the author observes, occupy a great deal of room and are great consumers even when they are doing nothing. He observes that his tube (his cylinder) would be less inconvenient; "but as they could not," says he, "conveniently put ordinary oars in motion, it would be necessary to use revolving oars." Papin states that he had seen similar oars attached to an axeltree on board of one of Prince Rupert's vessels, which was worked by horses. His (Papin's) method of producing a rotary motion by the ordinary movement of the piston is as follows: "The rods connected with the piston should be indented in order to turn the little cog-wheels, fastened to the axles of the paddles." But as a piston does not exert any useful effort at the close of its downward course, in order to preserve the continuity of the rotary motion, he conceived the idea of employing a number of cylinders the pistons of which should operate in contrary directions, so that one should begin to descend as the other reached the termination of its downward stroke, etc. "But it will, perhaps, be objected," adds Papin, "that the racks of the pistons being caught in the teeth of wheels, would in rising and descending, give opposite motions to the axeltree, and that in this way the pistons which rose would hinder the motion of those which were descending; conversely, those which descended would hinder the action of those which ought to rise. But this objection is easily obviated; for it is quite a common thing for watchmakers to fasten toothed wheels upon

\* These wheels had been used by the Romans to propel their galleys, hence any modern claim to the use is futile. See M. Arago's own admission on this head in a subsequent page.—TRANS.

† See the Quarterly Review for 1818, vol. XIX, p. 353 and 355. By this quotation it is plain that M. Arago is unacquainted with the American articles on this subject, and hence cannot be considered as authority in this case.—TRANS.



shafts or axles, in such a way that being impelled towards one side they necessarily cause the axle to turn with them, but towards the opposite side, they can turn freely without giving any motion to the axle, which may thus have a motion entirely opposite to that of the said wheels. The greatest difficulty then merely consists in erecting a manufactory for making tight tubes, thick and equal from one end to the other, etc.\*

Papin proposed then, in print, to propel ships by means of the steam engine, forty-two years before Jonathan Hull, who is looked upon as the inventor of steam navigation in England.\*

The process explained by Papin for changing the rectilinear motion of the piston into a continuous rotary motion, is not inferior, I think, to that of the English machinist; for according to the latter, the wheels attached to the principal axis and the paddle wheels, only communicate with each other by cords.

The two cylinders, acting alternately, which Papin thought of making use of to regulate the motion of the wheels, are not so despicable as one might think them. Mr. Maudsley, one of the most able English constructors, has used them lately in many of his large boats to supply the place of the fly wheel, which cannot be used without great difficulty in a confined space.†

The substitution of a paddle wheel for ordinary oars, belongs neither to Papin nor to Hull; to say nothing of Prince Rupert's sloop cited by the former, we shall find in very old authors evident proofs of the employment of wheels. As to the first exact experiments upon which any judgment could be formed of the relative advantages of these two methods of impulsion, they can be hardly traced higher than the year 1699, and we are indebted for them to Mr. Quet,‡ (see. mach. appr. par l'acad. t. 1st.)

\* What a step from the proposal to propel ships to its execution!—TRANS.

† The plan adopted long since by Mr. Stevens of two cranks at right angles connected with the same piston is much more eligible.‡ But M. Arago seems not to have turned his attention to American mechanics or their devices, or to American writings on the subject of the steam engine.—TRANS.

‡ Mr. Robert Stuart's work (see page 83, 3d edition,) contains the following passage; "Jonathan Hull ought to be honorably mentioned for having pointed out paddle wheels, moved by a steam engine, as a means of propelling vessels without wind and sails. This proposition requires a change in the rectilinear and alternate motion of the rod of the piston into a rotary motion. Hull showed that a crank gave an ingenious solution of the problem. We now see rightly in this invention the origin of the introduction of the steam engine in the manufactories as impellers of every kind of mechanical operations." Thus, in the opinion of Mr. Stuart, Jonathan Hull has the double merit of having invented steam vessels, and of having shewn that the steam engine might be substituted for the mechanical agents hitherto employed in manufactories of every kind. I have but one objection to oppose to these conclusions; which is, that Papin's work, in which the idea of boats, and that of a continuous rotary motion communicated to a wheel by a steam pump, preceded the work of the engineer, Hull, by 42 years.

An English *Savant*, a friend of mine, to whom I communicated verbally the results contained in this memoir, told me that if I ever should publish it, he would confute all my assertions by passages taken from French authors. "It will be," added he laughing, "a war of quotations." Begging him to explain himself farther, I discovered that the arguments which he meant to array against me would be derived either from a biographical article upon Newcomen, from the pen of one of the most illustrious philosophers of our day, or in a memorial concerning steam vessels drawn up by the celebrated professor of mechanics in the Conservatory, and approved by the Academy of Sciences. In these two articles, I am compelled to admit, the opinions of English authors upon the inventors of the steam engine have been unreservedly adopted. The objection has therefore some weight, but it does not appear to me to be con-

In speaking of steam engines in general, I have endeavoured to give a share of the notice to the inventors, properly so called, and another to the engineers, who have been the first to turn the invention to account. If we continue to follow the same plan we shall find:

That M. Perier was the first, in 1775 to build a steam vessel, (a work of M. Ducrest, printed in 1777, contains the discussion of the experiments which this engineer witnessed; their date is therefore authentically verified);

That experiments on a larger scale were made in 1778, at Baume les Dames, by the Marquis de Jouffroy;

That in 1781, M. de Jouffroy, putting his plans into execution, actually established a large boat of the same kind, upon the Saône, which was not less than 46 metres long, with 4.5 metres beam.

That the minister of that time addressed the report of the favorable results given by this vessel, to the Academy of Sciences in 1783, with the view of deciding whether M. de Joffroy had a right to the exclusive privilege

clusive. As to what respects the memoir of Newcomen, I will remark in the first place that it is evidently copied from Robison's history; that the distinguished writer to whom we are indebted for it, no where announces that he has made particular research upon this occasion, or, that he has consulted original documents. If he had cited Solomon de Caus, I should have doubtless entertained scruples as to the importance which it appeared right to me to give to the researches of the French machinist; but his name is not found once in the biography, although, we find in large letters, those of Worcester and Savery. From this I think I may conclude with certainty, that the works of Solomon de Caus, and I presume those of Papin also, were unknown to my learned brother; (*confrère*)—his opinion ought not therefore to be opposed to mine, since I shall have the right, like an ancient Greek philosopher, to appeal from Philip to Philip better informed.\* In reference to the second objection, I shall easily set aside the authority of the Academy of Sciences by remarking that its invariable rule is only to decide upon the *conclusions* of the reports presented to it. The developments, be they more or less extensive, which accompany these conclusions, do not give rise, on its part, to any deliberation, the reporter alone is responsible for them. Now the very minute report respecting steam vessels, which was read before the Academy on the 27th of January, 1823, winds up with *conclusions* in which I do not find a single word in relation to the inventors of the steam engine. The Academy has therefore decided nothing that can be brought in opposition to my views. As to the text of the report itself, I find in it, it is true, that the English were the first to employ steam power for raising water; that Worcester is the inventor, whose ideas Savery developed; that Jonathan Hull was the first who thought of propelling vessels by means of the steam engine, but as I neither see there the name of Solomon de Caus nor that of Papin, although, whether for good or evil, they were occupied with these same questions before the English mechanicians, I may claim the right to reproduce here the reflections which the article in the Universal Biography suggested to me some time ago. Besides, the authorities, however respectable, are in this place of no importance. The question is reduced to the simple point, whether the works by which I have supported my argument really bear the date assigned to them, and whether my extracts are faithfully made. Though all the Academies in the world should decide, by common consent, that Worcester first conceived the idea of impelling water by the elastic power of steam, it would not be less an established fact that the idea belonged to Solomon de Caus, since 1615 preceded 1663. As long as it has not been proved, in like manner, that the year 1695 followed 1736, Papin, in spite of all reports past, present, and to come, will have the merit of having proposed steam vessels 42 years before his competitor Jonathan Hull.

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\* For the same reason on the subject of the high pressure engine, and of the Steam Boat, we appeal from M. Arago to M. Arago better informed.

which he claimed,\* (Messrs. Borda and Perier, were appointed a committee on it);

That the trials made in England by Mr. Miller, Lord Stanhope and Mr. Symington are of a much later date, (the first should be referred to the year 1791; Lord Stanhope's, to 1795, and the experiment made by Symington in a canal in Scotland, to the year 1801);

Lastly, that the attempts of Messrs. Livingston and Fulton at Paris, not taking place until 1803, could with so much the less propriety give title to the invention, in that Fulton had had a minute acquaintance in England with the experiments of Messrs. Miller and Symington, and because many of his countrymen, Mr. Fitch, among others, had devoted themselves to the subject by public experiments from the year 1786.\* Let it be observed, however, that the first steam vessel, which was not given up after being tried; the first which was applied to the transportation of men and merchandize, was that which Fulton constructed at New York, in 1807, and which made a trip from that city to Albany. In England the first steam vessel established for the convenience of commerce and travellers, dates as far back only as 1812; it navigated the Clyde, and was called the Comet. The second began to run in 1813; it made trips between Yarmouth and Norwich.

*Contrivances which render the Steam Engine self-acting.*

The first of Newcomen's engines required the constant attention of a workman who opened and closed, alternately, various valves, sometimes to let steam into the cylinder, and sometimes to admit the water required to condense it. Tradition attributes the first invention of the contrivance, by means of which the engine itself opens the valves at the proper time, to a boy named Humphrey Potter. It is said that Potter, disconcerted one day at not being able to go and play with his companions, took it into his head to tie the ends of a piece of pack-thread to the handles of the two cocks which he was stationed to open and shut; the other ends being fastened to the working beam, the pull which it occasioned in rising or descending, did the office which had been performed by hand. Beighton, the engineer, improved very much upon this idea, by fixing a bar of wood called a *plug-frame*, vertically, to the working frame. This bar was provided with various plugs, which bore upon the stems of the different valves, at convenient times determined by the vibration of the beam. Beighton's mechanism was adopted by Watt with some advantageous modifications. The distribution of steam into the various parts of the cylinder, is now effected by simpler means which have entirely superseded the use of the *plug-frame*, at least in engines in which the power is not excessively great, and which are intended to communicate a rotary motion. This contrivance, which I will not here attempt to describe, as without drawings it would perhaps be unintelligible, is called an *eccentric*. An eccentric wheel attached to an axis turned by the engine, gives two opposite motions to the slide, during each of its revolutions; these two motions suffice to admit the steam from the boiler above and below the piston suc-

\* The vessel tried at Lyons, contained two distinct steam engines. The events of the French revolution compelled M. de Jouffroy to emigrate, and all his efforts were consequently without result.

† Rumsey's name is not even mentioned by M. Arago, nor is he acquainted with the claims of Stevens, Evans, and others. It is highly desirable that some one acquainted fully with this subject would take up the assertion of our countryman's claims against the manifest injustice here and elsewhere done to them. The tardy admission made in the next sentence is not justice.



cessively, and to provide a convenient outlet towards the condenser for that which has already acted.

The mechanism of the slide and its eccentric, was contrived by Mr. Murray, of Leeds, in 1801.

In high pressure and double acting engines the steam is let in successively above and below the piston, and as soon as it has produced its effect is let off into the air. All this only requires a quarter of a turn of one and the same cock, called the four way cock. This very ingenious apparatus is uniformly employed at present in all the large water-engines made in Germany. Its invention belongs to Papin: it may be seen in the high pressure engine of this machinist, a figure of which is given by Leopold, and in that which Leopold himself subsequently proposed, in the year 1724.

### *The Crank and Fly Wheel.*

Mr. Keane Fitzgerald published in the Philosophical Transactions, for 1758, p. 727, *et seq.*, the description of a process for transforming the rectilinear motion of the piston of a steam engine into a continuous rotary motion. For this purpose he made use of a rather complicated system of toothed wheels, several of which were ratchet-wheels. Thus far the method of this engineer agrees with that of Papin; but he improved upon it by adding to this mechanism, a *fly-wheel*, a valuable contrivance for regulating the motion of steam engines, now in general use, and the honour of which justly belongs to Mr. Keane Fitzgerald.

While the oscillating motion of the working beam of a steam engine was transmitted to the revolving axis by the intervention of toothed-wheels, it was exposed to fractures, very vexatious in themselves, and the more so on account of the interruptions of work which they occasioned. In 1778 Mr. Washborough of Bristol, proposed to make this communication by means of a crank connected with the revolving axis. This, it will be perceived, was simply to make use of an expedient found in all spinning wheels, and in the apparatus of every knife grinder.

Nevertheless a patent having been taken out, a contrivance which every body was at liberty to make use of when the motive power was either the foot of a man or a current of water, was interdicted to the engineer whose engine operated by steam. In order to avoid the tax which he would have been obliged to pay to Mr. Washborough for each one of his engines, Watt made use of a communication of motion slightly different, until the expiration of the patent right which the former possessed; this operated by means of a toothed-wheel fastened to the revolving axis, which he called the *sun wheel*, because its centre remained fixed, and another wheel also furnished with cogs attached to a rod from the working beam, and which, as it revolves round the other wheel, he called the *planet wheel*. It would be of no use to describe this piece of mechanism more particularly, since Watt himself used the crank as soon as he could.

### *The Parallel Motion.*

In Newcomen's or Watt's single acting engine, the working beam terminated in the arc of a circle, and a flexible chain, attached to the upper extremity of that arc was the means of communicating between these two parts of the apparatus. When the piston descended by the pressure of the atmosphere, it *pulled* the beam. When the beam rose again by the action of a counterpoise placed at the opposite extremity, it *pulled* the piston. Now

though a chain, however flexible it may be, is always excellent for a pull, it will not answer to push, and hence the double acting engine requires a different connection. In the descending motion of the piston it draws the beam; but in the succeeding motion, or when the beam rests again, it ought to be *propelled* from below upwards: which the chain cannot do. The first contrivance, therefore, required modification.

The first modification adopted consisted in cogging a part of the rod of the piston, to make a rack of it, which caught in a circular arc, also cogged, and fixed to the extremity of the working beam. This is what Papin proposed in 1695.

Subsequently, Watt devised a much preferable method, which is now generally adopted wherever there is no want of room; it is called the *parallel motion*. It would be very difficult for me to give a complete description of it here, without figures. Suffice it to say that a parallelogram the four angles of which have four pivots, and which consequently may assume all sorts of angles without ceasing to be a parallelogram, is attached by its two upper angles to the working frame of the engine; that the piston rod is fixed to one of the lower angles, and that the fourth angle is fastened to a stiff radius rod, movable round a fixed centre. Whatever the position of this centre, if the lever attached to it remain of invariable length, the parallelogram changes its shape during the vibrations of the beam, being sometimes a rectangle and sometimes a rhomboid. But when the centre to which the lever is attached is suitably chosen (herein the discovery of Watt consists) the angle of the movable parallelogram of variable form, *to which the piston rod is attached*, does not sensibly depart from the vertical during the vibration of the working frame. The motion of the piston is in this manner perfectly regulated and its communication with the working beam taking place by the intervention of an inflexible system, it can with the same ease *draw* the beam downwards during the descending motion of the piston as *force* it upward when the piston rises. The jointed parallelogram attracts the strongest attention from persons who witness the operation of a steam engine for the first time. To the eyes of the practised machinist, it presents itself as an apparatus of easy construction, entirely exempt from concussion, and susceptible of indefinite duration. It is evidently one of Watt's most ingenious inventions. The patent in which it is described is dated in the month of April, 1784.

#### *The Governor.*

The pipe which, in Watt's engines, lets the steam from the boiler into the cylinder, contains a thin plate, or valve, similar to the dampers which are fitted in our stove pipes. In a certain position, the plate leaves the opening of the pipe almost entirely free; in another it is entirely closed, and in the intermediate positions of the valve, the opening is greater or less according to its approach to the two limits just mentioned. The valve may be moved by a handle attached to the axis which is prolonged to the outside of the pipe.

If the valve is entirely open the steam fills the cylinder very rapidly; if it is nearly closed, it requires, on the contrary, a considerable time to effect the efflux of the same same quantity of steam. Now the number of seconds occupied by the strokes of the piston depends evidently upon the rapidity of the pressure of the steam upon one or other of its surfaces. The turning valve in the tube gives, therefore, in a certain degree, the means of regulating this rapidity.

If the axis of the valve terminates on the outside of the pipe in an elbow so as to form a crank, the strokes of the piston can be accelerated or retarded by turning this crank in one direction or the other. Suppose, for instance, that the crank must rise if the piston moves too fast, and should be retarded; and that it should descend, on the contrary, when the piston goes too slowly. By fitting a piece to the engine which must necessarily rise when the working is accelerated, and necessarily descend as soon as it is slackened, the problem would be solved, for it is only necessary to connect this piece in some way or other with the handle or crank of the valve. Such is the object of the contrivance which Watt called the *governor*. This apparatus is composed of an upright spindle which the engine turns more or less rapidly according to its own rate of working. Upon the upper end of this axis is fitted a horizontal pivot, to which two metallic rods are suspended by joints working freely, so that they may fly off, more or less, from the vertical. Each rod has a large metallic ball at the end. When the vertical axis is set in motion by the engine, the balls which turn with it fly apart to a certain limit, by the action of their centrifugal force. If the action of the piston becomes more rapid the balls fly farther apart, or approach nearer to each other in the opposite circumstances. In the first case the balls rise, and in the second descend. These rising and falling oscillations are communicated by levers to the handle of the revolving valve of the tube which supplies the steam, and any considerable alternation in the speed of the engine is in this way obviated. This apparatus, composed of movable rods with balls, this conical pendulum, as it was formerly called, had been long used as a regulator on the flour mills. It was also used to regulate the opening of flood gates of streams employed in setting overshot wheels in motion. This last application was precisely like, both as regards the end and the means, to that which Watt made of it, in adapting it to the steam engine, in the year 1784.

[TO BE CONTINUED.]

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## Civil Engineering.

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*Description of Black Rock Tunnel, on the Philadelphia and Reading Railway.*  
By W. H. WILSON, Civil Engineer.

Black Rock Tunnel on the line of the Philadelphia and Reading Railway, is 1932 feet in length, 19 feet in width, and  $17\frac{2}{10}$  feet in height. The form of the roof is a semi-ellipse of 19 feet base, and  $6\frac{3}{10}$  feet height; the sides are perpendicular for five feet down, and then curved so as to give a width of  $17\frac{7}{10}$  feet at bottom, or 18 feet on a level with the top of iron rail, which is 10 inches above the bottom. The floor is level throughout, and the area of the cross section is  $301\frac{5}{10}$  square feet.

This tunnel was adopted to avoid the necessity of following a bend of the Schuylkill river, by which the distance would have been increased upwards of a mile and a half, and several abrupt curves made necessary. In order to facilitate the excavation, and afford a proper ventilation, six shafts were commenced, to be used both as working and air shafts; one of these was abandoned at the depth of 28 feet, in consequence of great interruption from water; the remaining five were excavated to the required depths. The depths to bottom of tunnel, are as follows:  $116\frac{6}{10}$  ft.,  $139\frac{4}{10}$  ft.,  $138\frac{7}{10}$  ft.,  $100\frac{8}{10}$  ft., and  $82\frac{1}{10}$  ft., and the diameter of each is seven feet. Instead of



being placed, as usual, over the centre of the tunnel, the shafts were located on one side, by which arrangement the difficulty of giving the proper direction for mining was somewhat increased, but the danger to workmen below from the accidental falling of bodies in the shafts considerably lessened.

The shafts were arranged in pairs (100 feet between each two) for the purpose of affording greater certainty in obtaining and preserving the proper direction of tunnel. The short space between two adjacent shafts being excavated first, two correct points were obtained in the centre line of tunnel, 100 feet apart, from the range of which the long drifts could be worked with accuracy. At first one gin was used for every two shafts, the bucket in each being alternately up and down, but as by this plan the material could not be taken away as fast as it was excavated, it became necessary to erect a separate gin for each shaft.

While sinking the shafts, common windlasses were used, worked by men, but when the drifts were commenced, the gins were put in operation. Each gin had two buckets attached to it, and was worked by two horses. The depth of open cutting at the North end of the tunnel is 47 feet, and at the South end  $54\frac{5}{10}$  feet; the material as well as that removed from the tunnel and shafts was a very hard silicious slate rock. In sinking the shafts, it was found that but two men could work to advantage at the same time, one with a hammer, the other with a drill; this kind of work, laborious at any time, was made more so in this instance by the extreme wetness of the shafts, in consequence of which the tour of duty was limited to eight hours out of twenty-four, and in one of the shafts, for a short time, to six. At the top of each shaft two labourers were required to work the windlass and empty the buckets; these men were changed every twelve hours. The excavation of the tunnel was driven from both ends and from the five shafts, the area of the cross section being divided into two parts, of which the upper, comprising the arch, or roof, was excavated first, except in some few cases, where the peculiar stratification of the rock obliged the workmen to change their usual direction. At each end of the tunnel two separate bodies of workmen were constantly employed, one at the heading and the other some thirty or forty feet behind, completing the excavation to the full size.

In the drifts connected with the shafts, but one set of men could be worked to advantage, on account of the great difficulty in getting away the material. A set of men for one heading generally consisted of one superintendent and fourteen Miners, working seven drills; in addition to which, from two to five labourers were required to remove the material excavated. The time of labour was from six to six o'clock, deducting one hour at noon and at midnight, for meals, so that each man worked eleven hours out of twenty-four. Temporary railways were laid in each drift, upon which small cars with low wheels were used; the cars at the ends of the tunnel were larger than those in the other drifts, and so constructed as to tilt their burthens. At the shafts a bucket with a false bottom, secured by a hinge and bolt, was placed upon the car, then filled and rolled to the foot of the shaft, where it was attached to the rope; at the top, the bucket was hoisted sufficiently above the ground to admit of a car being run under it, when the bolt was knocked out, and the material fell into the car by which it was conveyed away.

The buckets used were two and a quarter feet in depth, two feet six inches in diameter at bottom, and two feet two inches at top, holding about nine cubic feet; those for raising water were about the same size, but made in a neater manner, with a valve in the bottom for letting off the water.

The ropes used were one inch and a half in diameter, and passed around the large drum of the gin a sufficient number of times to prevent slipping; at each end was attached a hook with a spring to keep the bucket from getting off accidentally, and the length was such that one end would be at the top of the shaft while the other was at the bottom. From the time the shafts attained a depth of about 70 feet until the drifts leading from them became connected with each other, it was necessary to use some artificial mode of ventilation. Several different plans were tried, but the following was the most effectual; a wooden pipe about four inches square was secured to the side of the shaft by irons driven into the rock, and was attached at the upper end to a fanning machine; the wooden pipe was not allowed to reach quite to the spot where the miners were at work, as it would have been liable to injury from blasting, but the deficiency in length was supplied by a bag or pipe of canvass, which could easily be moved when necessary. The partial use of this machine was sufficient to supply a proper quantity of fresh air. This work, including the deep cuts at each end, and about seventeen hundred feet in length of grading adjacent to the south end, was contracted for by Mr. James Appleton on the 21st of October, 1835. In December the excavation of the shafts and deep cuts was commenced. On the 8th of March, 1836, tunnelling began at the North end, and in the course of the ensuing summer, drifts were successively started from the other points. The work was prosecuted night and day with very little intermission until completed; the number of men employed amounted at one period to about 450. The last junction of drifts was effected on July 7, 1837, and the excavation completed the same year. In July, 1838, the track on this division of the Railway was opened for public use. About 670 feet in length of the tunnel (heading) were worked from the ends, the remainder 1262 feet being excavated from the shafts. The following tables exhibit the progress made in excavating.

*Sinking Shafts.*

|             | No. of days. | No. of nights. | Spaces of 12<br>hours each. | Depth exca-<br>vated in feet. | Average depth<br>excavated<br>every 12<br>hours |
|-------------|--------------|----------------|-----------------------------|-------------------------------|-------------------------------------------------|
|             |              |                |                             |                               | Feet.                                           |
| Shaft No. 1 | 177          | 151            | 328                         | $101\frac{6}{10}$             | 0.31                                            |
| “ “ 2       | 38           | 18             | 56                          | 28                            | 0.50                                            |
| “ “ 3       | 214          | 166            | 380                         | $125\frac{4}{10}$             | 0.33                                            |
| “ “ 4       | 245          | 202            | 447                         | $126\frac{8}{10}$             | 0.28                                            |
| “ “ 5       | 173          | 120            | 293                         | $93\frac{1}{10}$              | 0.32                                            |
| “ “ 6       | 128          | 85             | 213                         | $70\frac{6}{10}$              | 0.33                                            |
|             | 975          | 742            | 1717                        | $545\frac{5}{10}$             | 0.317                                           |

## Heading of Tunnel.

|                  | No. of days | No. of nights. | Spaces of 12 hours each. | Length excavated in feet. | Average length excavated every 12 hours. |
|------------------|-------------|----------------|--------------------------|---------------------------|------------------------------------------|
| North end        | 312         | 247            | 559                      | 522                       | Feet.<br>0.93                            |
| South end        | 156         | 138            | 294                      | 185                       | 0.63                                     |
| From Shaft No. 1 | 66          | 67             | 133                      | 86 $\frac{5}{10}$         | 0.65                                     |
| " " 3            | 156         | 156            | 312                      | 236                       | 0.75                                     |
| " " 4            | 131         | 131            | 262                      | 113                       | 0.43                                     |
| " " 5            | 245         | 235            | 480                      | 316                       | 0.66                                     |
| " " 6            | 177         | 170            | 347                      | 224                       | 0.65                                     |
|                  | 1243        | 1144           | 2387                     | 1682 $\frac{5}{10}$       | 0.705                                    |

In the above tables, the second and third columns show the number of days and nights occupied in excavating the depth or length specified in the fifth column; the fourth column is an addition of the days and nights, showing the number of spaces of twelve hours each. It will be observed that the total of the fifth column in each table, does not correspond with the amount of work of the kind belonging to the tunnel; the balances not specified, were done at irregular times or with irregular forces, and would not consequently give a correct average. The following is the total cost of the tunnel and end cuttings:

|                      |                          |              |
|----------------------|--------------------------|--------------|
| Excavation of tunnel | 21713 cubic yds. at 5.80 | \$125,935 40 |
| " shafts             | 881 " " 20.00            | 17,620 00    |
| " open cuttings      | 22126 " " 1.00           | 22,126 00    |
| Masonry of façades   |                          | 2,832 00     |
| Incidental work,     |                          | 3,239 00     |

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\$171,752 40

The above includes work done and materials furnished of every description, no extra allowance being made for bailing water, use of machinery or any thing else. Among the items of expense incurred by the contractor, as stated by him are \$6680 for powder, and \$4372 for candles. The rock through which the tunnel is excavated is sufficiently solid to render unnecessary any support to the sides and roof, a cut stone façade at each end being all the masonry required. The hill at the north end of the tunnel rises very abruptly from the Schuylkill river, which is crossed by a neat stone bridge of four spans, situated on the same straight line with the tunnel. During the progress of the work several veins or seams were met with, containing calcareous spar, intermixed with sulphurets of iron and zinc, from which many beautiful specimens were taken. It was a source of much satisfaction to all concerned, that the junctions of the several drifts were effected without accident, and that the levels and lines of direction coincided exactly throughout the whole length. The above description has been compiled from a diary kept by the writer, who had the immediate management of the work, under the direction of Messrs. Moncure and Wirt Robinson, principal engineers of the Philadelphia and Reading Railway Company.



*Eighth report of F. R. Hassler, as superintendent of the survey of the coast of the United States, and of the construction of standards of weights and measures; rendering account of the works of 1839.\**

*Upon the survey of the coast.*

1. The proper organization and course of operation in a geodical work of such extent as the survey of the coast of the United States, is dictated by the nature of the country, and the relative position of its parts; presenting a long stretch of very unequal coast, with only such a breadth as the exigences of the work required; this dictated to begin at such an approximately central part of the country as would present the most facility and best prospects for large triangles, to serve as foundation of the work, and produce the greatest quantity of data for that purpose in the shortest time; presenting, also, within its limits, a locality for a base line of proportional length, and the necessary facility for its accurate measurement, from which the work might afterward spread in both directions of the country simultaneously, and alternately, as circumstances would dictate or allow.

2. Thence the work was begun in the neighborhood of New York Sound, Long Island, and its large sound, &c., which evidently present the requisites and qualifications above stated. The works of the preceding years had filled up with the main and secondary triangulation, and the topographical, as well as hydrographical detail, most part of the district from the Jersey shore of the Raritan and New York bay, till towards the east end of Long Island, the Sound, and opposite islands, the shore of the main land of New York, Connecticut, till Black Point, &c.

3. The field works of this last season were in some measure a beginning of the stepping over from the eastern side of these works to the southwestern, to open on that side, also, the field for the topographical and hydrographical detail works through the southern parts of New Jersey, part of Pennsylvania, to the seashore of Jersey, along Barnegat bay, and the Delaware.

4. All the survey of Long Island, as well the topographical, as the hydrographical part of its outer seashore on the south, and that of the sound to the north, had been completed the preceding years, till to Gardner's bay, of which a part of the sounding remained yet for this year.

5. The works of this year on the northern shore of the sound, include, as well the topographical, as the hydrographical surveys of Block island, the numerous islands of Fisher's sound, and others, the shore of Connecticut, and Rhode Island, with their deep inland waters, from Black point, where the hydrographical works had ended last year, through the whole of Fisher's sound, so that the work reaches now on that side of the shores and waters of the eastern States.

6. The surveys on land were carried inland as far as the nature of the coast on one side, and the time on the other, dictated or allowed; always furnishing, to the hydrographical party, which is carried on parallel with the works on the shore, the fundamental points to ground their determinations of the points of sounding upon them: these works occupied one of the sounding parties, and a number of topographical parties.

7. The other sounding party finished the works in Gardner's bay, thence

\* From Congressional Documents, 26th Congress—1st Session—read to the Senate December 27th, 1839.

round Block island, along the shores of the row of islands, turning up to the main, and a part of the main shore, in continuance of where the other party left off, from the side of Fisher's sound; a part of the same topographical parties furnishing the determining land points as always usual.

8. A second part of the work to be executed this year, in that eastern part of the survey, was the topography of the parts, between the country near the shore, surveyed with reference to the sounding more especially, and the limit of the main triangulation, farther in the interior; the former having always been accelerated in its progress, so as to assist constantly the hydrographers in their progress on the water, it could not be carried sufficiently deep, land inward, for all the wants of the survey in general, this part of the topographical works was therefore to be completed, and it required yet some secondary triangles to complete it, besides the plain table works. It appears, however, that the season will not serve long enough to prevent operation if it fall yet in next year's work. But this will not prevent the house works of mapping, which are intended to be done the coming winter for that part of the country.

9. A work similar to the above, but of much smaller extent, was executed on the west side of the New York and Raritan bay through the county from the North river near the sloat on the west side of the Hudson river, corresponding opposite to Tarrytown, on the east side of it, which is the boundary point from which the work, which has just been mentioned, starts towards the east.

The western limit of this work following the Newark mountains, and the triangle points established upon them, until to their intersection with the Raritan river behind New Brunswick, and to the parts surveyed as shore line in that part of the country.

10. Thus the survey of the whole country from the New Jersey shore of the Raritan bay, Sandy Hook, and Shrewsbury, till to the waters of the eastern States is completed in topography and hydrography, grounded upon and included in, a great number of secondary triangles, which themselves are based upon the main triangulation.

Only over a small portion, at the east end, the primary triangulation does not yet reach, but the secondary triangulation is accurate enough, and near enough to the main triangles upon which they are grounded, to secure against all doubts upon sufficient accuracy for the detail operations of topography and hydrography. When the main triangulation will be again carried to that side of the work, it will soon cover it over. The whole of the works presents to the south in some measure a straight line, from which the work will proceed southerly through New Jersey and Pennsylvania.

11. Views for the guidance of the navigator approaching the shore as mentioned in the last report, have been made last summer by one of the assistants, on the whole extent of the outside coast of Long Island, and at such places of the eastern part of the sound, as were found properly the hydrographic parties, who had of course to lead the selection of these points; these are of two kinds, the one guiding, the others warning. The first are aspects of the shore from the most important points of a channel or entrance of a port, &c., by which the seaman is guided in his proper course in approaching. The second kinds are views taken from rocks, shoals, or other dangerous places in the approaches of the shore, which the view given shall warn him to avoid.

12. In extension of these principles, the views of every light-house were taken double, first from the habitual ship channel at a distance at which

vessels would habitually pass it, and second from the proximity, where the light-house becomes entirely visible, and so near as to warn from nearer approaching unless special views of landing, &c.

The south shore of Long Island is well known for its dangers by the multiplicity of shipwrecks on it; therefore, special direction was given to draw views from the habitual ship channel outside, at every short interval, or in some kind of a moving panorama, by which the approaching seaman may reconnoitre the part to which he is near, and guide himself in his course by the views which he is thus shown that he shall meet in succession in his intended course.

13. From Sandy Hook southerly, the Jersey seashore, with Barnegat bay, and a certain breadth along the inner shore of the same, has also been surveyed, till down to the neighbourhood of Egg Harbour river. This part of the shore is difficult of access, from the interior by triangulation, on account of the heavy wooded, but low hills which separate it from the other land of Jersey, so that it will become unavoidable to cut through the forests in various places, to get lines for triangles, joining this work to the interior parts in several places, in order to bind up with accuracy the long series of small operations, necessitated by the peculiar difficulties presented by the nature of the locality. The hydrographical part of the same locality was also intended to be begun, but as it could not be attended to this year, it will form the first work for sounding vessels next spring.

14. The extension of the secondary triangulation over New Jersey, between the Raritan bay, the Delaware and the seashore, for which the accurate first elements are given by the main triangulation, carried entirely to the same extent; and from the southern line, stated above, for all other works, was carried in advance of the main triangulation the most favourable points. This same operation has been continued this year more southerly, so as to lay out triangles for further extension westerly, to join the head of the Chesapeake, including in its course the northern monuments of the so called Mason and Dixon's line.

15. It is well known that the meridional parts of this Mason and Dixon's line has been applied to conclude upon the length of a degree of the meridian in that country and latitude, and that the result has been used, in former times, by European mathematicians, in their comparisons with the other measurements of degrees in different parts of the world, but gave so unsatisfactory results as to be always rejected. It will, therefore, be of interest in the course of the present survey, if ever possible to verify the meridional distance, by means of the triangulation for the coast survey, and the latitudes of the two end points, either by the same, or by new astronomical observations.

16. The scientific account of the operation being recorded in the transactions of the London Philosophical Society, that part can be easily verified. But the monuments placed on the ground may, or may not, be found again in the old places, with the necessary accuracy to warrant proper confidence. In the archives of the State of Maryland such documents exist as may give a clew to designate the localities of them. Therefore there have been already some researches made upon the subject, and the verbal accounts of the persons living in the neighborhood may fully lead and decide upon the application of the diplomatic documents, that will be found to the locality when compared upon the spot. Whatever may be the result, this investigation is of scientific interest, and can, therefore, not be passed over



uninquired or unverified in a work like the coast survey, passing over the same ground.

17. From some proper points below Philadelphia, there will be a branch of the triangulation carried on easterly towards the sea, to join the topographical works made along the seashore, Barnegat bay, &c., as stated above, and also southerly to Cape May and Cape Henlopen, at which point it will be proper to join again both these two series of triangles.

18. The place of Cape Henlopen light-house must form a point of the main triangulation, though lying somewhat out of its shortest course, to bind up and compare with all accuracy, the results of the latitude and longitude determinations, made there on the occasion of the passage of Venus over the sun in 1769; which is another scientific work, executed in that neighbourhood in the last century, and a more interesting one than the preceding, it being generally considered as more accurately executed.

19. This summer the main triangulation has been carried on through Jersey, from the triangle points lying in the district of the works first enumerated, southerly to the neighbourhood of Philadelphia; how far it may be possible to continue it south of it, must of course, depend upon the weather, which at this time of the year is very uncertain. Over all this district the secondary triangulation must necessarily next year be carried more into details, and the topographical parties will also begin operations in it.

20. The main triangulation having been begun earlier this year than the former, more stations of it have been executed, and it will be brought as soon as possible, in following years, to the head of the Chesapeake bay; the part of the country thereby obtained will then present again a systematic mass of work, connected so as to form the elements of another series of maps and data for publication, similar to the works now executed and above enumerated.

21. The results of the whole work in triangulation, topography, and hydrography, as far as obtained, the end of last year, were last spring collected together in one map, upon the scale of  $\frac{1}{100000}$ , as already noticed in my last report as begun; every separate sheet of work is there numbered, as it is in the register of the works, and its limits marked, so that any execution of maps, within the limits of the work, can be guided by this preliminary in some measure tangible register of the works; the same system is, of course, to be pursued in future.

22. It will be a special question to decide in each case of executing any map from the coast survey works, upon what scale it shall be executed, according to the different aims and purposes; this register map will in all cases give the means to form appropriate plans upon that subject, calculate the size and position of the whole map of the sheets, or any part of them.

23. During the coming winter the assistants will again be occupied as in the preceding ones, only the calculations being of a somewhat different nature, principally relating to the systematic junction into one body, of the results of the trigonometric operations that have been executed; all the calculations are always to be made three-fold; being now numerous, much of the time of the assistants will be used in it, and as well this as the reduction of some of the works to ultimate maps for final execution, will occasion to keep some of the assistants engaged in this work, instead of in the field work.

This arrangement is well appropriated to the work in its present stage, and, at the same time, agrees with the state of the balance remaining from

the last appropriation, as it will postpone some of the expenses of the field equipments.

24. This will make ready for any final execution for drawing, &c., the whole extent of the coast and country adjacent, from the New Jersey shore to the end of Rhode Island shore, in the topographical and in the hydrographical parts.

This part of the coast, forming, in some measure, a whole work by itself, containing about three thousand square miles, will therefore be taken in hand immediately, for final execution upon two different scales, for the different purposes, to which they must naturally serve in future.

25. The map of the bay and port of New York, which has been especially mentioned last winter, as desired to be published, forms an essential part of this work, and will, of course, be attended to the first, with this view, for which arrangements are in progress.

26. A provision of the best quality of large drawing paper, appropriated to our work from the manufactory of Aunouay has just been announced as having arrived in New York for our use.

27. With the view to prepare for engraving maps, copperplates have been ordered in Vienna from Hungarian copper, on account of its best quality: these have just been announced as being under preparation, and that they may be expected in a few months: they will, therefore, certainly arrive before actual use will press for them.

28. In respect to the appropriation for the coast survey, to be proposed to Congress at the next session, I have only to state that it will be most economical for the best progress of the work, that Congress would please to appropriate \$100,000, as I had taken the liberty to propose last year, because it will be necessary to begin incurring special and new expenses, for the arrangements and provisions required for executing final drawings, and begin to engrave. If the final appearance of the maps, when published, shall do justice to the trouble and expense incurred in the survey, the whole must come out of one systematic establishment, from which nothing should go out without the stamp of the establishment.

29. It is not proper, nor in fact possible, to separate these works from the drawings consequent upon the coast survey generally, because the works naturally interlock in one another, so that no distinct account can be kept, nor the works be detached from the assistants, who have worked at them in their origin; there should, therefore, be applied for the final drawing the necessary preliminary expenses of different kind of engravings, &c., such moneys of the appropriation total as may be needed, and the whole will enter into one mass of expenditure, like it is one system and map of work.

30. Except these establishments, and the expenses which must naturally be incurred in consequence thereof, there will be no change in the assistants employed, and the general arrangements and organization of the work, so that it is expected the diminution of some of the field expenses, as mentioned above, will about cover the additions which the last two sections show as necessarily to be added in the present state of the work: this presents a stepping over towards its full fruition at an epoch of its age, shorter than I believe can be shown in other similar work.

*Upon the construction of the standards of weight and measures.*

1. Since my last report upon these works, the full sets of weights for all the custom houses have been delivered and distributed according to their destination.

2. Weights had been prepared to become, when standardised, the heavy ounce weights for the mints, to be grounded upon the sets of ounce weights, till to the one hundred ounce weight, which were delivered to the mint in Philadelphia, early in 1833, as has been reported upon in proper time.

The mint having, in the meantime, constructed more accurate balances, desired for the sake of acceleration, to receive these weights in that unfinished state, and adjust them in their own establishment. This being granted by the Treasury Department, the whole of the sets, with their packing boxes, &c., complete, were delivered to the director of the mint at Philadelphia, and also the beam of an unfinished brass balance, of large size, which had been begun, and which they were in need of, to assist in the adjustment of the weights delivered.

3. The principal attention in the way of adjustment of standards this year, was put upon the numerous yards ready for it, a task which it is impossible to make hasty, and which requires in all cases continued and very fatiguing application; many thousands of microscopic observations are required for it. The specialities of these minuted parts of the work belong rather to an ultimate full account of all the means and methods employed in the execution of the whole task of the establishment of the standards which it will then be proper to publish, and distribute on Government account, like a similar account of the works of Mr. Bessel, of Königsberg, for the establishment of a standard length measure, has been published lately by the Government of Prussia.

4. The feeling lever apparatus, which Professor Bessel has directed to be made for this establishment, at Berlin, he has lately announced to me as being nearly ready, so that it may perhaps yet arrive before the final delivery of the yards. This would afford the opportunity of establishing some comparisons by two methods, by the microscopes, and by the lever, which would be the more desirable, as the latter is intended to remain in the establishment for future use in comparisons.

5. A number of yards sufficient to furnish all the States are ready; but it is not proper to deliver them as yet, as it will tend to more accurate coincidence, to combine more numerous comparisons, under a variety of temperatures, and with different means. Besides the original standard scale of eighty-two inches, described in the report, upon the comparison of the weights and measures of the custom-houses, various other sets of microscopic arrangements were constructed, and constantly employed, whereby always a number of comparisons are carried on at the same time.

6. The form of the yards is that which has been formerly already mentioned, as best adapted for the preservation of their accuracy; the yards being cut to a length, in about the half breadth of a strong brass bar, and fitting between the butting pieces at both ends of a similar bar of equal thickness, which it fills exactly, so that when joined they form one piece, and nothing can ever touch the ends, which determine the exact length; this arrangement presents evidently two different means of ascertaining the length of the yard to the nicest; but it should be used only when it is desired to give the length of other yards that are intended *to form again standards*. For the transfer of the yard for common purposes, there is a special decimally divided length of a yard traced upon the outer piece of the yard, or matrix, between two parallel lines. A tracing arrangement is given with it, by which means, the yard being left undisturbed in its proper place, in the box fitted for it, a bar of metal, or wood, for which a location is made parallel to the yard, can be laid off and subdivided, without in any way injuring the



original; the use of this will be described in a statement to be added, as instructions at the delivery of the yards. My assistant worked at a considerable number of these divisions, until interrupted by sickness.

7. Of the liquid capacity measures the full number is finished, until to their adjustment, which requires their being weighed filled with distilled water, at the temperature of the maximum density of water, which is a most tedious and minute, therefore not very quick operation.

For the use in it a special balance has been constructed. Their actual adjustment will begin immediately after that of the yards, when the arrangements which it requires will be completed. Handles of a peculiar construction, to take off and put on, are constructed for their proper manipulation in use, without changing in the weighing.

8. As it is necessary to close the tops of the vases exactly at the proper height, to contain a determined weight of distilled water, at a given temperature, in a given cubic space of a brass vessel, it is necessary that this vessel be *exactly* covered, no air bubbles admitted in it, and no overflowing; to effect that, glass plates are required, exactly plane, of proper thickness, ground, unpolished on the side which touches the liquid, and of the size of each vessel's top; only large plate glass factories can procure these good; to construct them expressly would have necessitated a great establishment, different in its kind from all that is now established, therefore these plates have been ordered at the manufactory of plate glass of St. Gaubin, where they can be made with ease; which has established arrangements for such works, and can execute them at short notice, and with proper accuracy; they will, besides, cost a great deal less than in any other way.

9. The half bushels require a manner of casting different from that of the other parts of the work, which takes also more time and special cares; it has been in full operation, as much as possible; but this casting cannot be made in our establishment at all seasons of the year with equal success, and will, therefore, suffer temporary interruptions; during which other castings are executed. Some of these half bushels have also been turned; but it is evident that in the proper order of the work, there could not yet be any attempt towards their adjustment. The glass plates, that shall serve to cover them, have been ordered, together with those for the capacity measures for liquids for all of them: the proper size has been given to the factory for guide.

10. Thus it appears that the different tasks of the establishment for standard weights and measures have advanced properly, each in that proportion which the kind and the quality of the work they require, indicate naturally as the time required for their execution. The weights being already fully executed and delivered, except the ounce weights for the States, have made known in the country what is to be expected from the establishment, and have, I believe, given general satisfaction, which I doubt not every part of the works will give, whenever it appears before the public.

F. R. HASSLER.

*Station of Willow Grove, Pennsylvania, November 16, 1839.*

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*Reply to a query relating to the Area of an Excavation or Embankment. By a Correspondent.*

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN,—In the January number of the Journal of the Franklin Institute, a correspondent requests a demonstration of a formula for calculation.

VOL. XXV.—NO. 2.—FEBRUARY, 1840. 9



*Statement of the Performance of the Locomotive Engine "Gowan and Marx," built by Messrs. EASTWICK & HARRISON, Philadelphia, on the Philadelphia and Reading Rail-Road, with a train of one hundred and one loaded Cars. February 20th, 1840.*

Gross weight of train, including cars and freight, but not including Engine or Tender, 423 tons of 2240 lbs.

Net weight of freight,  $268\frac{1}{2}$  tons of 2240 lbs.

The freight consisted of—2002 barrels of flour, 82 do. whiskey, 459 kegs of nails, 19 tons of bar iron, 22 hhd. of meal, 5 do. whiskey, 4 do. oil, and sundry other articles, making a total of  $268\frac{1}{2}$  tons.

Distance from Reading to the foot of the Inclined Plane on the Columbia Rail-Road,  $54\frac{1}{2}$  miles. Running time of the engine with train, five hours thirty-three minutes; rate 9.82 miles per hour. Coal consumed, red ash anthracite, from Schuylkill county, 5600 lbs. Water evaporated, 2774 gallons.

#### *Grades of Road.*

The total fall from Reading to the point where the train was stopped near the Columbia Rail-road, is 214.5 feet, being an average fall of 3.94 feet per mile. There is *no ascending grade* from Reading to the Columbia Rail-Road, with the exception of about 2100 feet at its lower termination, graded at 26.4 feet per mile, upon which grade the train was stopped: the other grades vary from 19 to 15 feet per mile: there are only three miles graded at 18 feet and one at 19 feet per mile.

The total length of *dead level* line from Reading to the Columbia Rail-Road is 27 miles and 4200 feet: of this, the longest level is 9 miles and 500 feet long, between Norristown and the inclined plane: the others vary from 1550 feet to 4 miles and 1600 feet in length.

#### *State of the Track.*

Owing to the frost coming out of the ground at this season, the track was in worse order than at any other time of the year; this, however, did not materially affect the performance of the engine, as the embankments were all in nearly as good order as at other times: and at comparatively few points in the deep cut, was the track sufficiently out of line or level to offer increased resistance to the train.

The superstructure of the road consists of a T rail, 45 lbs. to the yard laid upon sills 7 feet long and 7 by 8 inches square, 3 feet  $1\frac{1}{2}$  inches apart from centre to centre, and laid on broken stone.

#### *State of the Rails.*

For the first twenty miles the rails were in very bad order, the morning was cloudy, and a fog of the previous night had left sufficient moisture on the surface of the rails to diminish considerably the adhesion of the engine: for the remainder of the distance the weather was clear, and the rails in good order.

#### *Working of the Engine.*

On three different occasions the engine started the whole train on a dead level, and when on a dry rail, without the wheels slipping.

The steam ranged from 80 lbs. to 130 lbs. per square inch, to which latter pressure the safety valve was screwed down.



The draught of the engine was created by the escape steam passing into, and from, a tubed exhaust box—no other draught was used while running: at the water stations, “Reilly’s patent fan” was used when fresh coal was thrown on the fire, but at no other time.

The speed of the train was noted when passing through some curves of 819 feet radius on the 9 mile level, and found to be 9.8 miles per hour: on a straight line on the same level, the engine attained a speed of 10.5 miles per hour.

So little was the engine affected by her performance on the 20th, that on the 23rd she drew, on her return trip, 88 burden cars, 9 of which were loaded, and a locomotive engine, making a gross weight of 163 tons of 2240 lbs., not including engine or tender, up a grade of 18.4 feet per mile. The train had a strong head wind against it during the whole trip, which, owing to its length, 1206 feet, was sensibly felt at some exposed points of the road, and must have proportionably affected the power of the engine.

*Weight and Dimensions of the Engine, “Gowan and Marx.”*

Weight when empty 21,640 lbs. In running order, with fuel and water, 24,660 lbs., on four driving wheels in running order, or with water, fuel and two men, 18,260 lbs. Cylinders  $12\frac{3}{4}$  by 16 inch stroke; 8 wheels, 4 of which are driving wheels, coupled, 3 feet 4 inches diameter; truck wheels 2 feet 6 inches diameter.

The weight of the burden cars averaged from 1.5 to 1.65 tons, of 2240 lbs. each: they were all 4 wheeled—wheels 3 feet diameter, and 4 feet 6 inches apart from centre to centre.

The above performance, of an 11 ton engine, is believed to exceed any on record in this or any other country.

G. N. NICOLLS,

*Superintendent Transportation, Philad. and Reading R. R.  
Reading, Feb. 24, 1840.*

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### Bibliographical Notice.

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*An Introduction to Astronomy; designed as a Text Book for the Students of Yale College. By DENISON OLMSTED, A. M., Professor of Natural Philosophy and Astronomy. New York—Collins, Reese, & Co., 1839. pp. 276, 8vo.*

The above is the title of a new publication, on the Elements of Astronomy, by a gentleman whose name is already well known to the scientific public, as the author of a treatise on Natural Philosophy, and as a writer on the subject of Meteorology, in several articles which have appeared in Silliman’s Journal. We had previously two American works on the elements of Astronomy; one by Prof. Gummere, of the Haverford Institution, near Philadelphia; and the other by Prof. Norton, now of Newark College, New Jersey; each having its peculiar merits, and each, as we think, having its faults, regarded as a College Text Book. We are obliged to express the same opinion of the work now before us; and whether it be considered as a defect or as an excellence, we think it the most popular and the least abstruse of the three. For ourselves, we would have preferred a greater amount of algebraical investigation; but perhaps that desideratum will be supplied in

the second part, which is yet to appear, and for which the calculations of eclipses, and other problems, with the requisite tables, are reserved.

After preliminary observations on the History of Astronomy, and the Copernican system, Prof. Olmsted naturally commences with the Figure of the earth, and the Doctrine of the Sphere; then treats of Parallax and Refraction, the measurement of Time, and the use of Instruments. He next proceeds to the Solar System, the Sun, and its apparent annual motion, with its causes and effects; after which follows the theory of Universal Gravitation; next the study of the Moon, its motions and phenomena, then the study of the Planets, beginning with the inferior; next that of the Comets; and lastly the study of the Fixed Stars; in regard to which last, this work is more full and satisfactory than its contemporaries. We think that the measurement of Time would have been taken more properly in connection with the Sun's apparent motion in a subsequent chapter; with which exception the general arrangement seems to be very judicious. Still, in our judgment, the value of the work would be enhanced, by a larger proportion of analytical demonstration, and exact, instead of approximate data; which though not necessary to the common reader, are yet important to the inquisitive or practical student. With these remarks we conclude by saying that every teacher of Astronomy will derive advantage from an examination of this, as well as of the other works herein named; but each one must judge for himself which work is best adapted to the wants and capacities of his pupils.

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## Franklin Institute.

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### *Annual Meeting.*

The annual meeting of the Institute was held at their Hall, January 16th, 1840.

THOMAS FLETCHER, Vice President, in the Chair;

JOHN G. CLARK, Recording Secretary, P. T.

The minutes of the last quarterly meeting were read and approved.

Donations were received from the Royal Geographical Society, of London; the Institution of Civil Engineers, of London; the Zoological Society of London; Prof. M. Faraday, William Vaughan, Esq., and Petty Vaughan, Esq., of London; the Royal Irish Academy, of Dublin; Prof. Jno. Millington, of Virginia; L. D. Chapin, Esq., Wm. C. Redfield, Esq., and Jno. D. Griscom, M. D. of New York; Mr. Jonathan Dennis, Jr., of Rhode Island; Major James D. Graham, Washington City; J. Edgar Thompson, Esq., Professor Denison Olmsted, of Connecticut; John C. Trautwine, Esq., of Tennessee; J. R. Livingston, Esq., and Thomas Ridgway, Jr. Esq., of Pennsylvania; William Strickland, Esq., L. Vanuxem, Esq., Henry Seybert, Esq., James J. Barclay, Esq., Chas. Ellet, Jr. Esq., R. C. Taylor, Esq.; Professors Henry D. Rogers, and Alex. Dallas Bache, the Medical Society of Philadelphia; the Trustees of the Girard College for Orphans; the Mine Hill and Schuylkill Haven Rail Road Company; and Messrs. Thomas Wardle, John Wilson, Jacob Snider, Jr., John D'Homerger, George W. Edwards, Esq., B. M. Hinchman, Esq., Samuel Cupp, Esq., James Ronaldson, Esq., and Jacob Lex and Son, of Philadelphia.

The Actuary laid on the tables the periodicals received in exchange for the Journal of the Institute.

A communication was read from Mr. John R. Lambdin, accompanied

by a likeness of James Ronaldson, Esq., the President of the Institute, painted and presented by Mr. Lambdin. The frame presented by Mr. John Struthers.

The annual report of the Board of Managers was read and accepted, and referred for publication.

The Treasurer presented his report of the funds for the last quarter, and also a statement for the year ending December 31st, 1839, which were read and accepted.

Mr. John Horten, from the Committee of Tellers of the annual election for Officers and Managers of the Institute for the ensuing year, (appointed at the preparatory meeting this day), presented their report of the result of the election; when the Vice President declared the following gentlemen duly elected.

JAMES RONALDSON, President.

ISAIAH LUKENS, }  
THOMAS FLETCHER, } Vice Presidents.

ISAAC B. GARRIGUES, Rec. Sec.

ALEX. DALLAS BACHE, Corr. Sec.

FREDERICK FRALEY, Treasurer.

*Managers.*

|                      |                      |
|----------------------|----------------------|
| Samuel V. Merrick,   | Andrew M. Eastwick,  |
| Abraham Miller,      | Isaac P. Morris,     |
| William H. Keating,  | Charles B. Trego,    |
| John Struthers,      | Henry Troth,         |
| Matthias W. Baldwin, | John S. Warner,      |
| Isaac Hays,          | William Hart Carr,   |
| J. Henry Bulkley,    | Robert M. Patterson, |
| Alexander Ferguson,  | Henry D. Rogers,     |
| John Agnew,          | John Gilder,         |
| John Wiegand,        | Ambrose W. Thompson, |
| Samuel Hufty,        | George Taber,        |
| John C. Cresson,     | Thomas U. Walter.    |

Extract from the minutes.

THOMAS FLETCHER, *Vice President.*

JOHN G. CLARK, *Rec. Sec. P. T.*

*Sixteenth Annual Report of the Board of Managers of the Franklin Institute, of the State of Pennsylvania, for the promotion of the Mechanic Arts.*

In conformity with the Constitution, the Board of Managers respectfully present to the members of the Franklin Institute their report for the past year, containing a brief summary of the operations in the several departments of the Institution. The leading object of the Association, that of giving opportunities of increase in knowledge to its members, and those connected with them, has as heretofore been steadily kept in view. The lectures on science and its application to the arts continue under the charge of our able Professors to instruct and interest the large class in attendance upon them, and embrace as usual the subjects of chemistry under the charge of J. K. Mitchell, M. D., Natural Philosophy and Mechanics under that of Prof. Jno. C. Cresson, and of Technology under that of Prof. James C.



Booth. It is due to these gentlemen to express the continued satisfaction felt by the Board with their exertions; an expression in which they are sure they are joined by the classes in attendance upon the lectures. In addition to members tickets for the lectures, there have been issued this year, 45 lady's tickets; 216 minor's tickets, and three stranger's tickets. The course of the Drawing School has been interrupted by a cause calling for the sympathy of the members, the long continued illness of the teacher, Mr. William Mason; the Board are happy to state that Mr. Mason has been able to provide a substitute in his son, already an experienced teacher, and the school was opened on the 13th of the present month under his charge.

The situation of master in the Architectural department of the Drawing School, rendered vacant by the resignation of Mr. John McClure, has not been filled, owing to the fact that the Carpenter's Society had opened a school under their direction, with the success of which, the Board were unwilling in any way to interfere, and which they have supposed supplied all the requisites of their own school.

The committee on the library have been active in endeavoring to add by purchase to the already useful collection of scientific works belonging to the Institute. During the past year 108 vols. have been added by purchase, 32 by exchange, and 24 by donations, and the library now contains 2364 vols., exclusive of a large collection of Pamphlets. The number of periodicals received for the use of the reading room has been increased by the addition of several foreign Journals, and the list of newspapers has been kept at its former extent. The cabinets of minerals and models have been increased by donations; the former being now well arranged affords useful means for the study of Mineralogy, or for reference; the latter occupies an increasing share of attention, especially from strangers visiting the city, and introduced by members; it may, when the means of the Institution shall allow, be made a source of great attraction, and of much solid popular instruction.

No opportunity has yet occurred to enable the Board to press further the establishment of a School of Arts, but the importance of the object is by no means lost sight of. The Monthly Meetings of the Institute, which afford suitable occasions for bringing forward new inventions and discoveries, have been kept up with spirit thus far during the season, and are well attended.

In addition to these modes of conveying instruction to the members, the Journal of the Franklin Institute was established to diffuse knowledge on Mechanics and other branches of science in even a wider circle. In its department of original matter, this journal affords a vehicle through which mechanics, engineers, and men of science may bring their views before the public, and here, also, carefully prepared notices and descriptions of patents for American inventions are to be found. These notices and descriptions are the fruits of the labor of Dr. Thos. P. Jones, whose experience and ability in this particular line are universally admitted. Instead of presenting a crude mass of matter, good and bad, by publishing indiscriminately the specifications of all patents, the Editor is at the pains to give abstracts containing the substance of the whole, and only in cases where the subject warrants, giving the entire specification to the public. The selections from foreign Journals form the chief labor of the second Editor, Prof. John Griscom. The efforts made in securing the services of gentlemen so eminent in their respective lines as the Editors whose names have just been given, and, in addition, the payments usually made for original articles for the pages of the Journal, are proofs that the Board continues, through its Committee of

Publications, to appreciate highly the good to be accomplished by the Journal in the promotion of the mechanic arts, and in the diffusion of useful knowledge.

Researches in science have at different times been fostered by the Franklin Institute: the labors of the Committee on Water-Wheels, and on the Explosion of Steam-Boilers have been brought to a close, and have each contributed to win for the Institute the reward of commendation for useful exertion rightly applied. The Committees on Science and the Arts, and that on Meteorology, may be ranked with the foregoing, as giving encouragement to researches, though not personally engaged as Committees in executing them. The Committee on Science and the Arts have examined by Sub-Committees thirty-nine different inventions or improvements during the past year. When the Committee acted merely as the counsellors of the inventor, the reports are not considered matter for publication; in other cases, when the objects seemed worthy of it, the reports have been ordered for publication in the Journal of the Franklin Institute.

The Scott's legacy premium and medal, the award of which is entrusted by the City Councils to the Franklin Institute, has been conferred by this Committee on three of the gentlemen whose inventions were submitted to them, namely, on Thomas Wood, M. D., for a fountain pen, and mechanical method of determining areas; on Thomas Ridgway, Jr., for a transit theodolite for mining engineers; and on L. C. Denison, for a Corn-sheller. The medal to accompany this premium has been prepared, and is a beautiful specimen of the Art; the obverse has a head of Franklin in high relief, and the reverse the words "The Scott Premium. To the most deserving." The die was executed in the transfer lathe by Franklin Peale, Esq., by the aid of an iron casting admirably executed by Isaac Babbitt, of Taunton, Massachusetts. At the first meeting of the Committee in 1839, the Chairman, Dr. R. M. Patterson, having declined a re-election, Prof. A. D. Bache was chosen Chairman.

The Committee on Meteorology have continued the distribution of the instruments ordered by the State of Pennsylvania, to observers in the different counties, and report a condensed statement of the observations through the pages of the Journal.

The importance of exhibitions of domestic manufactures, and of the products of the various branches of the Mechanic Arts from time to time to improvement in their several branches is now generally conceded. The last exhibition of this kind held by the Franklin Institute was successful beyond former experience in the number and value of the products exhibited, and in the number of persons to whom they were displayed. The labors of the last Committee on premiums and exhibitions, will, it is hoped, be emulated by their successors, that the exhibition in the Autumn of 1840, may be rendered even more extended than that of their predecessors.

In conclusion, the Board of Managers must congratulate the Institute, that notwithstanding the pressure of the times which have weighed with peculiar severity upon those, upon whom the Institution depends for its support, the number of members has not been diminished, and the payments have generally been punctually met. The same is the case in relation to subscribers to the Journal. It may well be a satisfaction, that while in other years there has been an increase in the means of usefulness of the Institute; there has been during the past year no loss in reference to them. The proceedings of the late special meeting of the Institute to authorize the sale of property, are too recent to demand special notice in this report.

During the past year 125 new members have been elected, 100 members have resigned, and 21 have died. The following named gentlemen have become life members—

Hector Orr, Edward Miller, Ellwood Morris, Richard C. See, Jos. M. Truman, Erastus Fairbanks, A. L. Elwyn, M. D., George W. Smith, William Ashbridge, Jacob Ott, I. P. Morris, Jno. Struthers, and W. H. Carr.

Respectfully submitted by

JOHN AGNEW, *Chairman.*

WILLIAM HAMILTON, *Actuary.*

*Minutes of the Board of Managers.*

At a meeting of the Board of Managers, held at the Institute, January 29th, 1840,

Mr. JOHN C. CRESSON was elected Chairman of the Board; and

MESSRS. HENRY TROTH, and J. HENRY BULKLEY, Curators, for the ensuing year.

At a meeting of the Board, held February 19th, the Chairman nominated the Standing Committees, agreeably to the by-laws. On motion, Alfred Langdon Elwyn, M. D., was added to the Committee on the Library; John McClure, and Thomas S. Stewart, to the Committee on the Cabinet of Models; James C. Booth, and John F. Frazer, to the Committee on the Cabinet of Minerals; John C. Cresson, to the Committees on Publications, and on Premiums and Exhibitions; Roswell Parke, Jno. C. Cresson, Robert Hare, M. D., John K. Mitchell, M. D., and Jos. Saxton, to the Committee on Monthly Meetings; William Kirk, Charles Thomas, and Josiah Evans, to the Committee on the Exchange; Robley Dunglison, M. D., James P. Espy, C. N. Bancker, John K. Kane, Sears C. Walker, John C. Cresson, and Gouveneur Emerson, M. D., to the Committee on Meteorology; when the Committees were appointed as follows:—

*On the Library.*

|                      |                         |
|----------------------|-------------------------|
| Henry Troth—Chairman | Ambrose W. Thompson,    |
| Isaac Hays, M. D.    | Thomas U. Walter,       |
| Isaac P. Morris,     | A. Langdon Elwyn, M. D. |
| J. Henry Bulkley,    |                         |

*On the Cabinet of Models.*

|                          |                   |
|--------------------------|-------------------|
| Isaac P. Morris—Chairman | George Taber,     |
| John Struthers,          | John Agnew,       |
| Andrew M. Eastwick,      | Thomas U. Walter, |
| Isaiah Lukens,           | John McClure,     |
| William Hart Carr,       | Thomas S. Stewart |
| John Gilder,             |                   |

*On the Cabinet of Minerals.*

|                           |                  |
|---------------------------|------------------|
| Charles B. Trego—Chairman | Henry D. Rogers, |
| Isaiah Lukens,            | Thomas Fletcher, |
| Samuel Hufty,             | James C. Booth,  |
| Abraham Miller,           | John F. Frazer.  |

*On Publications.*

|                          |                      |
|--------------------------|----------------------|
| John C. Cresson—Chairman | Samuel V. Merrick,   |
| Isaac Hays, M. D.        | Matthias W. Baldwin, |
| Alex. Dallas Bache,      | Isaac P. Morris.     |



*Franklin Institute.**On Premiums and Exhibitions.*

|                         |                     |
|-------------------------|---------------------|
| John C Cresson—Chairman | Isaac B. Garrigues, |
| Alex. Dallas Bache,     | John S. Warner,     |
| William H. Keating,     | John Agnew,         |
| Alexander Ferguson,     | Thomes U. Walter,   |
| Thomas Fletcher,        | John Struthers.     |

*On Instruction.*

|                               |                   |
|-------------------------------|-------------------|
| Alex. Dallas Bache, Chairman. | Abraham Miller,   |
| Frederick Fraley,             | Charles B. Trego, |
| John Wiegand,                 | Henry Troth,      |
| Isaac P. Morris,              | Henry D. Rogers.  |

*On Monthly Meetings.*

|                               |                    |
|-------------------------------|--------------------|
| Alex. Dallas Bache, Chairman. | John S. Warner,    |
| Robert Hare, M. D.,           | William Hart Carr, |
| John K. Mitchell, M. D.,      | Roswell Parke,     |
| Joseph Saxton,                | J. Henry Bulkley,  |
| Andrew M. Eastwick,           | John C. Cresson,   |
| John Wiegand,                 | George Taber.      |

*On the Exchange.*

|                        |                 |
|------------------------|-----------------|
| John S Warner—Chairman | John Gilder,    |
| John Struthers,        | William Kirk,   |
| Andrew M. Eastwick,    | Charles Thomas, |
| Isaac B. Garrigues,    | Josiah Evans.   |

*On Meteorology.*

|                              |                           |
|------------------------------|---------------------------|
| R. Duglison, M. D.—Chairman. | Henry D. Rogers,          |
| James P. Espy,               | Sears C. Walker,          |
| Charles N. Bancker,          | John C. Cresson,          |
| John K. Kane,                | Gouverneur Emerson, M. D. |

*On Finance.*

|                         |                   |
|-------------------------|-------------------|
| Alex. Ferguson—Chairman | Frederick Fraley, |
| William H. Keating,     | Henry Troth.      |
| Samuel V. Merrick,      |                   |

*Managers of the Sinking Fund.*

|                        |                     |
|------------------------|---------------------|
| S. V. Merrick—Chairman | Alexander Ferguson. |
| Frederick Fraley,      |                     |

*Auditors.*

|                              |                      |
|------------------------------|----------------------|
| Isaac B. Garrigues—Chairman. | Ambrose W. Thompson. |
| William Hart Carr,           |                      |

(Extract from the minutes.)

JOHN C. CRESSON, *Chairman.*WILLIAM HAMILTON, *Actuary.*

## Mechanics' Register.

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LIST OF AMERICAN PATENTS WHICH ISSUED IN FEBRUARY, 1839,  
*With Remarks and Exemplifications by the Editor.*

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1. For an improved *Loom for Weaving Fringe and Trimmings*; Eliza A. B. Judkins, Portland, Maine, February 2.

This loom does not differ in its general construction from those already in use, but to obviate some inconveniences experienced in the ordinary loom, a new arrangement of certain parts is described and represented, and to these the claim is confined; a transcript of the claim would be of no use without the drawing.

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2. For improved *Cast Iron Wheels for Cars, &c.*; William W. Pennell, city of Lancaster, Pennsylvania, February 8.

This wheel is without spokes, one side of it consisting of an entire plate, which is supported by radiating brackets connected with it and with the hub. Towards the rim there is a circular cavity extending all around the wheel, which is formed by a core supported through openings left in the face of the wheel for that purpose.

The claim is to the constructing this wheel and combining the several parts together; "that is to say, in combination, the forming of the part towards the rim hollow, in the manner described, whilst the part towards the hub consists of a single plate, the two parts being connected and supported by brackets, as set forth."

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3. For a *Machine for making Oakum*; James Tibbals, Haddam, Middlesex county, Connecticut, February 8.

A cistern, or trough, is to be made which may be of wood, and this is to contain water to be heated by means of a furnace below the bottom of the cistern. The junk, cut into proper lengths, and opened by hand, is to be hung upon bars forming part of a vibrating carriage, traversing upon railways, so that the junk shall hang within the water, where it is to be subjected to the action of said water, assisted by a rapid vibratory motion of the carriage: when one end of the junk has been acted upon, the ends are to be reversed. The claim is to "the combination of the said horizontal carriage and its appendages with the other parts of the said machine, as above set forth; carrying junk in strands equally back and forth in hot water; and the application of the principle of vibratory motion, in the manner set forth, to the manufacture of oakum."

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4. For an improvement in *Bedsteads, Chairs, Sofas, &c.*; Edmund Chenington, Boston, Massachusetts, February 9.

The apparatus here patented is for raising and lowering the head part of bedsteads, sofas, &c., in a manner so analogous to what has been before, and frequently, done, that it is not worth while to attempt a description, or to give the claim; the latter, indeed, would not afford any idea of the peculiar arrangement of levers, &c., as made by the patentee, and to this, of course, he is limited.

5. For improvements in *Tanning*; William Brown, Thompson, Sullivan county, New York, February 9.

The improvements are said to consist in the changing the position of hides, sides, and skins, in the liquors, in all the different processes of tanning; viz, Liming, Bating, and Tanning, as a substitute for the ordinary mode of drawing, hauling, and laying away.

The hides, or skins, are to be suspended so as to hang down vertically, and parallel to each other, by taking two pieces of timber, and keeping them apart by a stretcher of the proper length for the vat,  $a$ ,|————| $a$ , the short pieces  $a$ ,  $a$  may represent the ends to which the skins are attached, and the long line the stretcher. The workman, walking upon a plank laid along the vat, is to remove this apparatus back and forth, by means of two handles extending up from the end pieces. The claim is to this arrangement.

6. For *Temples for Looms*; Jonathan Dennis, Jr., assignee of Kendall Gibbs, South Berwick, York county, Maine, February 13.

The patentee says that the nature of his invention "consists in constructing the temples with a joint, so that if the shuttle stops between the temple and the reed, the temple will be pressed back by the shuttle as the lathe strikes against the cloth, without injury to the shuttle, temple, or reed; this joint also allows the temple to vibrate towards the reeds, as it opens, and after it shuts; as the lathe leaves it, it vibrates from the reed with a reacting motion which makes the selvage, or threads, at and near the edge, tight, to any degree that the operator may require, thereby facilitating the entrance and exit of the shuttle."

After describing the particular arrangement of the temple, a claim is made thereto, referring to the matters so described. The temple is of the kind which holds the selvage between jaws, which are opened in the ordinary manner of such jaws, and the whole bears a very near resemblance to some temples which have been previously in use; the claim, if inserted, would not point out the particular difference.

7. For a *Paint Mill*; Joseph W. Webb, Mount Morris, Livingston county, New York, February 15.

A horizontal plate, which may be sixteen inches in diameter is to receive the paint to be ground. Towards the opposite sides of this there are to be two mullars, which may be cast six inches in diameter, and these are to be made to revolve on their own axes, by means of proper gearing, as well as around the plate. The mullars are to be surmounted by cups, or hoppers, into which the paint is to be put, which descends through an opening in the middle of the mullars. The bed plate is to be surmounted by a ledge to keep the paint from running off. The claim is to "the employment of two or more mullars constructed as herein described, which revolve around the centre of the bed plate whilst they rotate upon their own centres, as herein described."

8. For a *Liquid for burning in Lamps*; Augustus V. X. Webb, city of New York, February 19.

The liquid here patented the patentee denominates *Camphine*, or *Camphine oil*, and the patentee says that the nature of his discovery consists in "distilling with potash, or other alkali, and water, turpentine, or the spirit or oil of the turpentine, or other essential oils, whether separate or combined;



the results of which distillation is a liquid I denominate camphine." A still is described which is so constructed as to allow only the lighter parts of the fluid to pass over to the condenser, and the following claim is then made.

"What I claim as my discovery and desire to secure by letters patent, is the manufacturing of the liquid here denominated camphine, or camphine oil, which is produced by distillation with water and potash, or other alkali, turpentine, or other spirits, or the oil of turpentine, or other essential oils, whether separate or combined, and by whatever apparatus or mode the distillation may be effected."

We do not know of any substantial change that would be produced in the composition of the essential oil by the proposed process, and most assuredly, the process itself of distilling the essential oils from potash and water, has been performed times without number, although not for the purpose here proposed.

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9. For a *Lamp* for burning the liquid called Camphine; Augustus V. X. Webb, city of New York, February 19.

The lamp is of the kind formed by the frustums of two cones united at their edges, so as to leave the centre of the body free for the descent of the light from the burner; such lamps are in common use. The claims are to "the construction of the burner with a circular and continuous aperture between the upper edges of the frustums, to admit either a continuous circular wick in the form of a hollow frustum of a cone, or a circular perforated ring or plate to be used for burning camphine or any other article." The peculiar form of the glass chimney is also claimed; which form differs but little from those in common use, but possibly it may be thereby better adapted to the burning of the spirit employed, a question to be decided by experience only. There is a claim also to the regulating of the light by the raising or lowering of the chimney.

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10. For an improvement in *Fire Arms*; Libbeus Bailey, of Portland, Maine, John B. Ripley, of Claremont, and William B. Smith, of Cornish, New Hampshire, February 20.

The gun which is the subject of this patent is to receive its charges at an opening in the end of the breech. The particular arrangement of its parts cannot be given, these being too complex for verbal description, but the following quotation from the specification will afford some general idea of the general plan.

"This fire arm can be discharged about fifteen times to one loading; the operation is as follows: Fifteen sliding chambers are loaded with powder and ball, and a percussion cap pressed firmly upon each of the cones; these chambers are then passed into the cylindrical conducting tube through the opening at the breech of the gun, and then closed by shutting the cover; the gun is then brought to the shoulder and discharged; the gun is then brought down to a level with the hip, the cock drawn back with the thumb of the left hand, which leaves the drop free; the trigger is then pulled, the bolt drawn back, and the drop falls, and the discharged chamber falls into the left hand, the gun is then turned over with the barrel down, a slight motion will cause one of the sliding chambers to pass from the cylindrical tube into the receiving chamber, the apron, or drop, is then pushed down into its place, and the gun brought again to the shoulder and discharged, repeating the operation until the fifteen charges are expended."

If this gun has not yet followed the course of the numerous "improved fire arms," which have been made the subject of previous patents, it is no doubt on the road. There are few subjects upon which so much misapplied ingenuity has been expended within four or five years, as upon that of fire arms. They have been destined to be the subjects of a *report*, and have then been laid upon the table; and, we believe that the single barrelled gun, with its single charge, will not be generally superseded, either for the use of the army, or of the sportsman.

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11. For *Revolving Flashing Lights for Light Houses*; Benjamin F. Williams, Boston, Massachusetts, February 20.

The claim made under this patent is to the "rendering the revolving lights of light houses distinguishable from other revolving lights by means of vertical revolving shades, turned by wheels moving on a circular railway to the axis of which the shades are fixed, directly in front of the lights, which, when in motion, will cause the lights to appear and disappear in quick succession of sudden flashes."

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12. For a machine for *Pressing Hay, Cotton, &c.*; Joseph C. Baldwin, Staunton, Augusta county, Virginia, February 22.

This press operates by means of double progressive levers, of the kind called the toggle joint. The levers are connected to each other by a curved rack which is moved back and forth by a pinion gearing into it, which straightens the pairs of levers alternately. One end of each pair works on a joint in the frame work, whilst the other ends operate on notches in the shaft of a follower, acting, respectively, on its opposite sides, and alternately forcing it on, whilst they also alternately act as palls in holding it in place. The press is placed horizontally.

The specification of this patent has been amended, and the patent reissued; when we arrive at the reissue we expect to present it with an engraving.

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13. For *Protecting Plastered Walls and Ceilings from fire*; Peter Naylor, city of New York, February 22.  
(See Specification.)

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14. For a *Corn Sheller*; Alonzo R. Dinsmore, Chester, Rockingham county, New Hampshire, February 24.

This is said to be an improvement on Harris' corn sheller, a notice of which will be found at p. 262, of vol. xvii. The rubbing boards, in this improved machine are to be curved, one of them being made convex, and the other concave, by which change of form it is said that the machine will be rendered more efficient. This may be so, but we see no reason to alter the opinion originally formed and expressed respecting it, which is that it will be found to be one of the least useful of the shelling machines.

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15. For a *Crane Excavator*; William S. Otis, Civil Engineer, city of Philadelphia, February 24.

This apparatus is to be applied to the purpose of excavating in the constructing of railroads, and canals, and it has been used to a considerable extent by the inventor, and found to facilitate the operation to a very great extent. From the nature of the instrument its particular arrangement could only be made known by means of the apparatus itself, or of the draw-

ings. The apparatus excavates "by means of certain appendages to a scraper of the ordinary construction, which scraper is to be worked by a crane, and is to take the earth immediately from the banks from which the excavations are to be made.

"Although the improvement consists mainly in the manner in which I employ the scraper for excavating by means of the crane, I do not make any claim to the mere using of the scraper by means of the crane, this having been before done; but what I do claim in the apparatus described, is the application of power to force the scraper forward against a bank, in the act of excavating, and to withdraw it at pleasure by the aid of a barrel, chains, and other apparatus, constructed and operating substantially in the manner described, by which its sudden recoil will be prevented as it encounters any unusual resistance."

There are some other claims referring to particular parts, as represented, which it is unnecessary to insert.

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16. For an improvement in the manner of *Preparing Caoutchouc, Gum Elastic, or Indian-rubber*; Charles Goodyear, Boston, Massachusetts, Assignee of Nathaniel Hayward, Woburn, Middlesex county, Massachusetts, February 24.

(See Specification.)

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17. For a *Steam Apparatus*; Abraham Patterson, Rush, Susquehanna county, Pennsylvania, February 26.

This apparatus is said to be a substitution for the ordinary steam cylinder, a steam gauge, or a safety valve; yet we venture to predict that it will not be used for either purpose. In all its forms it consists of a cylindrical vessel, closed at its upper end, and open below, its lower end passing in between two concentric cylinders exactly in the manner of the gasometers used by chemists. Mercury is to be used to surround the first named cylinder, in the annular space within which it is to rise and fall, steam is to be admitted to cause it to rise, and to be condensed to cause it to fall. The claim is to "the employment of an apparatus constructed as herein described as a substitute for a steam cylinder and piston of a steam engine, and the safety valve of steam boilers. And I also claim the employment of mercury in the said apparatus for the double purpose of packing and steam gauge."

When this engine comes into beneficial use we will say more about it.

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18. For improved *Tailor's Shears*; Rochus Heinisch, city of Newark, New Jersey, February 27.

This improvement consists in widening out and so forming certain parts of the bows of the shears, as to constitute a bearing for the hand in grasping and using them, rendering it more easy to exert the necessary force in cutting. This is, no doubt, a real improvement; the claims are to the so constructing the shears, as described.



## SPECIFICATIONS OF AMERICAN PATENTS.

*Specification of a Patent for a mode of protecting Plastered Walls and Ceilings against the effect of fire; granted to PETER NAYLOR, city of New York, February 22nd, 1839.*

To all whom it may concern: Be it known that I, Peter Naylor, of the city of New York, in the State of New York, have invented a new and improved mode of protecting the walls and ceilings of such apartments as are usually finished with lath and plaster, against the effects of fire, by substituting perforated plates of metal for the laths of wood usually employed; and I do hereby declare that the following is a full and exact description thereof.

I take thin sheets of metal; preferring, so far as my experience has gone, tin plate, as prepared for the purpose of manufacturing tin ware, as I have reason to believe that the tinning protects the iron completely from the action of the lime used, and from oxidation generally. I do not intend, however, to confine myself in this particular, but to use any kind of sheet metal which I may find adapted to my purpose. When tin plate is used, the distance of the joist, or of the timbers generally to which it is attached, must be within the limits of the length of such plates,) but when sheet iron or other metal is employed, the distance may be greater.

I take the sheet metal which is to be used, and I punch numerous holes through it in the manner of a grater, using either a round, or chisel-edged, punch, as may be preferred; the diameter of these holes may be from an eighth to a quarter of an inch. When the plates have been so punched I nail them on to the joist, scantling, or studs, with the burred edges of the perforations outwards. For greater security I take strips of hoop iron which strips I nail on to the timbers, before nailing the sheet metal, and when this is done it would be difficult to heat the metal through its two thicknesses sufficiently to set fire to the timber, even without the protecting influence of the plaster.

The sheets of metal may be seamed together at their edges before nailing them on. When the sheet metal has been properly secured to the timbers I proceed to plaster the walls in the usual manner, omitting, however, the first rough coat which is necessary when laths of wood are employed. The plaster will pass through the numerous perforations in the sheet metal, and will be as securely keyed, and retained in place, as when done in the ordinary way. It has been found also, by experiments carefully performed, that the plaster will not flake off by a long continued heat so readily as it does from wooden laths, which warp and twist, and thereby aid in loosening the plaster.

What I claim as my invention, and desire to secure by letters patent, is the use of perforated sheet metal as a substitute for laths on walls and ceilings to be plastered, using and applying the same substantially in the manner herein set forth.

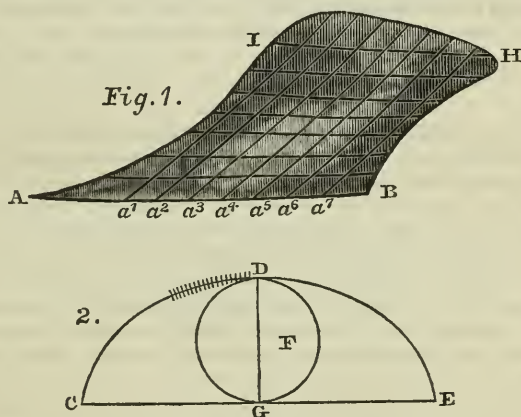
PETER NAYLOR.

*Specification of a Patent for an improved Mould-board for a Plough; granted to SAMUEL WITHEROW, of Gettysburg, in the county of Adams, in the State of Pennsylvania, and DAVID PIERCE, of the city of Philadelphia, October, 1839. Patent assigned to Samuel Witherow.*

To all whom it concerns: Be it known that we, Samuel Witherow of Gettysburgh, in the county of Adams and State of Pennsylvania, and David Pierce of the city of Philadelphia, in the same State, have invented an improvement in the manner of forming the mould boards of Ploughs, denominated by us the cycloidal mould board; and we do hereby declare that the following is a full and exact description thereof.

It is a principle resting on mathematical demonstration that a cycloidal arc, is that which offers the least resistance to a descending body; and it is hence deducible that an ascending body will pass up a cycloidal curve with less resistance than up any other.

The construction of our mould boards is dependent upon this principle. In forming them we employ the cycloidal curve in two ways, namely, to the formation of the concave of the mould board in the lines of ascent of the sward or furrow slice, in the act of ploughing. The second application of the cycloidal curve, is in the convex curve along the sole of the plough, constituting the part which enters and cuts the ground horizontally.



In the accompanying drawing, fig. 1, represents a mould board, A, being its point, and B, its heel; the line A, B, is that of the sole, constituting the lower edge which cuts the furrow slice horizontally. This curve in a plough which has been essayed, and has been found to answer well, was generated by a circle of eighteen inches in diameter.

In fig. 2, the curve C, D, E, may represent the cycloid generated by the circle F, the point D, which is that of the least curvature, corresponds with the point A, of the plough, fig. 1, the cycloidal line continuing to the hind part, or heel, at B. It will no doubt be advantageous to vary the curve according to the nature of the soil, a point to be determined by experience, but whatever variation may be found useful in this respect is still to be made in conformity with the principle upon which we proceed, namely, that of making it cycloidal. The line I, H, along the upper part of the mould

board, and in a plane parallel to that of the plane of the line A, B, we also make to fit the same cycloidal gauge.

In the plough which has been put in operation for the purpose of testing the principle, the lines of the ascent of the furrow slice, which govern the concavity of the mould board were regulated by a cycloidal gauge made to a curve, generated by a circle of sixteen inches in diameter. Let C, D, G, fig. 2, represent such a gauge, and the lines  $a^1$ ,  $a^2$ ,  $a^3$ , fig. 1, be assumed as those of the ascent of the furrow slice on the mould board; in forming said board we place the gauge in the direction of the line  $a^1$ , with the part D, which is that of least curvature at  $a^1$ , and thus proceed on until we arrive at the hinder part, B, H, withdrawing, or lowering, the gauge at its lower end at each successive application, so that a smaller portion of the least curved portion towards D, and a larger portion of that towards C, shall touch the mould board; these successive depressions may be indicated by the divisions at  $b$ , upon the gauge. The degree in which the mould board shall curve, and hang over at H, for turning the furrow slice, may be varied according to the judgment of the maker, the curvature being governed by the diameter of the generating circle, and the degree in which the gauge is depressed at every successive application of it.

Having thus fully set forth the nature of our invention, and shown the manner in which we carry the same into operation, what we claim therein is the giving to our mould board the segment of a cycloid, convexly on its face in line leading from front to rear, and concavely in the lines of the ascent of the furrow slice, in the manner and for the purpose herein described.

SAMUEL WITHEROW,  
DAVID PIERCE.

*Remarks by the Patentee.*—A principal object in ploughing is to pulverize the soil, and the only way in which this can be effected by the plough, is by bending the furrow slice on a curved surface, so formed as that it shall also twist it somewhat in the manner of a screw. Such a surface will be formed by taking a strip of iron and twisting it after the manner of a screw auger; and if there is given to this piece of iron a greater twist at one end than at the other, cycloidal curves may be thereby produced. Now as the curvature of the cycloidal mould board generally increases from the lowest to the highest point of ascent, it follows, necessarily, that the furrow slice in passing along it will be more and more bent as it ascends.

By forming the fore part of the mould board by means of that part of the cycloidal gauge which has the least curvature, and the hinder portion by that part which has the greatest, the bending of the furrow will continue, and be increased, as it passes horizontally, as well as in its ascent.

By forming the lines of ascent cycloidal concavely, and the horizontal lines cycloidal convexly, the twist in the mould board will gradually increase from the fore to the hinder part, as the curves contract, which will operate very advantageously in pulverizing the soil. The convex cycloidal form given to the horizontal lines will cause the furrow slice to leave the mould board in a direction well calculated to prevent it from falling off in segments. The advantages possessed by this mould board, as has been abundantly proved in practice, are, that it will run light, and that it will turn the furrow slice over in a connected sheet, well pulverized.



*Specification of a Patent for an improvement in the mode of preparing Indian Rubber for the Manufacture of various articles; granted to CHARLES GOODYEAR, of Boston, Massachusetts, Assignee of Nathaniel Haywood, February 24th, 1839.*

To all whom it may concern: Be it known that I, Nathaniel Haywood, of the town of Woburn, in the county of Middlesex and State of Massachusetts, have made a new and useful improvement in the mode of preparing caoutchouc, gum-elastic, or indian rubber, for the manufacturing of various articles in which that substance is used, and I do hereby declare that the following is a full and exact description thereof.

Sulphur, it is known, is soluble in the essential oils, which also are the solvents usually employed for dissolving caoutchouc, the oil of turpentine being generally employed for that purpose. I take the essential oil, say oil of turpentine, and dissolve in it, by digestion, a portion of sulphur, generally using about a teaspoon full of sulphur, in flowers, to the quantity of oil of turpentine which is to dissolve a pound of caoutchouc; the exact proportion not being important, and that indicated being sufficiently near for practical purposes. With this solution I proceed as with the ordinary spirits of turpentine.

Instead of making this solution of sulphur, I sometimes use the flowers of sulphur, or sulphur in fine powder, and incorporate it in the proportion above indicated with the gum when brought to a pulpy mass by any of the common solvents, or when worked by heated cylinders without any solvents, taking care that it is intimately mixed with the mass. Another mode of using the sulphur is to apply it to the surface of the gum after it has been applied to the cloth, or rolled into sheets, causing it to adhere by pressure or otherwise. After which the gum is to be submitted to the action of metallic salts, in the manner described by Charles Goodyear in the specification of letters patent obtained by him therefor.

The effect of the sulphur, in whatever way it may be added to the gum, is to cause it to dry more perfectly, and to improve the whole substance thereof, rendering it much superior to that prepared by any other combination therewith. The subsequent process of curing, or tanning, the surface above referred to, as patented by Charles Goodyear, removes all the odour of sulphur, and is intended to be generally applied to all articles manufactured as above.

What I claim as my invention and desire to secure by letter patent, is the combining of sulphur with gum-elastic, whether in solution or in substance, in either of the modes above pointed out, or in any other that is substantially the same, and which will produce a like effect,

NATHANIEL HAYWARD.

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### English Patents.

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*Specification of a Patent granted to HENRY PHILLIPS, of Exeter, for his invention of certain improvements in purifying gas for the purpose of illumination.—[Sealed 17th August, 1835.]*

The object of this invention is, to free coal gas from the ammonia which has such a corrosive effect upon all brass and copper fittings with which it

may come into contact. The method employed by the patentee for carrying this purifying process into effect, is by submitting the gas to the action of a saline solution, in the following manner:—

A suitable vessel, of a quadrangular shape, is fitted with a number of shelves perforated with holes, and upon these shelves is placed refuse tan, twigs, furze, pebbles, linen rags, or any other substances capable of retaining the saline solution for a time. Near the top of the vessel, and immediately below its lid, a perforated plate or shelf is placed, and covered over with a coarse linen cloth; this cloth is fastened to the plate by nails, which are driven through the holes, their points extending downwards for about an inch, or an inch and a half below the plate. The cover or lid of the vessel is then placed on and secured by a water joint so as to prevent any of the gas from escaping; the saline solution, consisting of alum, or any other suitable salt dissolved in water, is then admitted by a pipe, and allowed to run on the coarse linen cloth, the capillary attraction of the fibres will cause the saline solution to be distributed throughout its entire surface, and to drop down upon the tan, furze, twigs, or other substances on the shelf below. From thence the liquor continues dropping upon shelf after shelf, until it reaches the bottom of the vessel, whence it is extracted by means of an inverted syphon.

The gas to be purified is to be admitted at the lower part of the vessel, and allowed to rise through the tan, twigs, furze, or other substances upon the perforated plates or shelves, being subdivided in its passage, and obliged to enter into close contact with the saline solution, which deprives it of the ammonia.

When the gas has ascended to the upper part of the vessel through the coarse cloth, it is conveyed away by pipes in the ordinary manner; but if, upon testing the gas with litmus paper, it should be found that it has not been wholly deprived of the ammonia, it may, in like manner, be passed through another purifier similarly constructed.

The Patentee, in conclusion, says, that he lays no claim to the hereinbefore described apparatus separately, as it is constructed upon a similar plan to that employed in purifying gas by the dry lime process; he only claims it as being part of the apparatus by which his invention is carried into effect: and he claims more particularly as the invention secured to him by the present Letters Patent, depriving coal gas, employed for the purposes of illumination, of the ammonia contained therein, by passing the gas through, or causing it to enter into intimate connexion with saline solutions, as above described.

Lond. Jour. Arts & Sci.

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*Specification of the Patent granted to EDMOND HEUZE, of the County of Middlesex, for improvements in the Manufacture of Dextrine. [Sealed September 27, 1838.]*

The invention consists in the formation or manufacture or production of the substance known in chemistry by the name of dextrine, by means of the admixture and action of nitric acid, with and upon the farina of potatoes (usually called potato-starch) or the flour or starch of wheat, barley, or other appropriate farinaceous grain or seeds, and preparing such mixture as hereinafter described, whereby the same is converted into dextrine, at a much less expense, and in a state more serviceable for manufacturing purposes than by any means hitherto discovered. This operation may be per-

formed in different ways, but the following is the process which at present appears to me the best, and which I employ.

The farina, flour, or starch, being in a dry state, a portion of nitric acid of the specific gravity of about 1.4, equal in weight to one 400th part of the farina or flour, is mixed with such a quantity of pure water as is sufficient to wet the farina, flour, or starch, which is then carefully mixed with this fluid, so that every part of it may be wetted much as bread is mixed or kneaded.

It is not however necessary (though I think preferable) that the farina or flour of potatoes and similar substances, should be brought into a dry state, but it may be used as it is obtained by the maker from the tub or vat. In such case, a less portion of water will be required in the admixture of the nitric acid.

The paste thus formed is divided into lumps of any convenient size, say about twenty-five pounds weight, and these should be put to drain for a few hours, to allow any superfluous moisture to run off. The lumps should then be broken with the hands into small pieces, and placed in a chamber heated to any degree not exceeding 176 degrees Fahrenheit, and kept there till perfectly dry (which at the heat of 176 degrees will be done within twenty hours), and they are then reduced to the state of flour, by pounding or grinding, and the use of a bolter or sieve; and this flour is then placed in an oven heated to from 212 to 248 degrees Fahrenheit, where it is kept till thoroughly dry. The time necessary for this purpose will vary according to the degree of heat, from about a quarter of an hour to five minutes: the lower the degree of heat within the prescribed limits, the dextrine will be the whiter, which is advantageous.

When wanted to be used for any of the purposes which I shall presently describe, the dextrine thus obtained is to be mixed with water, either cold or hot. The proportion of water varies according to the consistence of the liquor required, which differs for different purposes. The product is a gummy or gum like liquor, similar to the solution of gum-senegal in water, and its principal uses are as a substitute for that gum.

The most general object for which the dextrine is used, is a substitute for the solution of gum-senegal and other gummy or gum like substances, in printing and dressing silk, cotton, linen, and other fabrics; in painting or printing paper-hangings, in all sorts of distemper painting, in stiffening the different fabrics which require it, such as gauze, and in all the preparations which required formerly the use of starch and calcined starch, calcined farina, or British gum; also in the preparation of adhesive plaisters and bandages for surgical purposes, in glazing visiting cards and other papers: in short, it is a perfect substitute for gum-senegal and other gummy and gumlike substances, in all processes of this nature with which I am acquainted, while it is much cheaper than any of them.

Any heated chamber and any oven in which heat can be obtained at the degrees mentioned above, will answer the above purposes.

I wish to observe, that I do not confine my invention to the particular process or preparation, or mode of mixing which I have above described. These are merely pointed out as the most convenient methods that I have discovered of employing my invention, which is the use of nitric acid mixed with water and farinaceous vegetable matter, and exposing it to the degrees of heat stated, so as to thereby produce dextrine—but I do not claim as new, or of my invention, the application of dextrine to the processes I have above mentioned, or any other.



*Specification of a Patent granted to GEORGE HADEN, of the County of Wilts, for Improvements in the Manufacture of a Soap or Composition applicable to the Felting, and other Processes employed in the manufacture of Woolen Cloth, and other Purposes for which Soap is usually employed.*—[Sealed October 8, 1838.]

My invention relates to the application of castor-oil, in substitution of the oils and other fatty matters heretofore used in soap making, whether for the processes of manufacturing woolen cloth or other purposes. The various modes of manufacturing soap being well known, and as my improvement by the application of castor-oil, does not interfere with such processes, it will not be necessary to enter into any particular description thereof, and the soap-maker will, as heretofore, vary the materials compounded with the castor-oil, according to the object he desires to attain.

I have found that the mixing at the rate of five cwt. of castor-oil with the caustic leys produced from one hundred weight of salts of soda, produces a very good quality of soap, when boiled and treated in the usual manner of soap boiling. I would, however, remark, that I do not confine myself to any particular quantities, nor to any particular matters which are to be mixed with castor-oil in the making of soap, as they will necessarily vary, as heretofore, in making soap from oil or other fatty matters.

The plant which produces the castor-bean is well known to be very productive, and will grow freely in the colonies of the British crown, particularly in the West Indies, and will become extensively in demand when soap is made therefrom, and may be produced and brought to England at a very low cost, and render this country independent of foreign produce. And I would have it understood, that what I claim as my invention is the application of castor-oil in substitution of the oils and other fatty matters heretofore employed in soap making.

Ibid.

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*Specification of a patent granted to OGLETHORPE WAKELIN BARRATT, of Birmingham, in the county of Warwick, for his invention of certain improvements in the process of decomposing muriate of soda for the manufacture of mineral alkali and other valuable products.*—[Sealed 19th January, 1839.]

In the common method of manufacturing sulphate of soda by decomposing muriate of soda or common salt with sulphuric acid and exposing the mixture to a strong heat in a furnace, muriatic acid gas is disengaged and is with difficulty condensed. Now the objects of these improvements in the said manufacture are the following:—Firstly, to effect the decomposition of the common salt without the application of heat and without the escape of muriatic acid gas, and which improvements are effected in the following manner:—

To about one hundred and thirty parts by weight of common salt dissolved in four hundred parts of water, add one hundred parts of concentrated sulphuric acid, and to this mixture put in sixty parts of metallic zinc in pieces of moderate size; on adding the zinc hydrogen gas is evolved or given off, which gas is to be collected in the usual way in any of the well-known apparatus for collecting and burning gases. The hydrogen gas so collected may be burnt and applied to the purposes of evaporation, or to any other purpose where light or heat is required.

When the zinc is dissolved, and time allowed for the sulphate of soda to form, or crystallize, draw off the clear supernatant solution, which contains chloride of zinc and a portion of sulphate of soda: then subject this solution to the action of heat, and by evaporation and cooling the remaining portion of sulphate of soda crystallizes, which is then added to the first crop. After this, wash the sulphate of soda in a hot saturated solution of common salt, which separates any chloride of zinc which may have remained mixed with the sulphate of soda.

In the above process it is evident that no heat is employed in the decomposition of the common salt, and that no muriatic gas escapes during such operation.

The object of the second process is to collect a portion of muriatic acid gas evolved from the mixture of muriate of soda and sulphuric acid when first brought together in a cold state, and then to finish off the charge or complete the decomposition of the salt and form the sulphate of soda by continuing or carrying out the process hereinbefore described. In this second process or operation an apparatus is employed suitable for the purpose—that known by the name of Woulfe's apparatus will answer very well.

To one hundred and thirty parts of common salt add one hundred parts of concentrated sulphuric acid. The vessel containing the salt and acid must be so constructed as to admit of the mixture being occasionally stirred with any convenient instrument or agitator, as a rake to facilitate the decomposition of the common salt, that portion of muriatic acid gas which is wished to be collected, being taken up by the water in the Woulfe's apparatus, in the form of liquid muriatic acid.

When muriatic acid gas ceases to evolve, and before the vessels are unluted, add to the charge of salt and acid four hundred parts of water; then remove the vessels containing the liquid muriatic acid, and add to the charge sufficient zinc to complete the decomposition of the common salt.

The quantity of zinc required for this purpose will be found to be about one third less than in the first process.

The hydrogen gas evolved from the mixture or charge is to be collected and applied; then crystallize the sulphate of soda and proceed as already described.

The solution of chloride of zinc obtained in the above-described processes is to be decomposed by means of any convenient agent so as to separate the oxide of zinc. The patentee has found lime to answer this purpose with the greatest economy: sixty-four parts of zinc dissolved will require for this purpose about fifty-six parts of lime of the best quality and reduced to the state of cream of lime by slacking and mixing with water; but if after the addition of this proportion of lime the solution should by the well-known tests appear to contain excess of acid, more lime must be used till it ceases to do so.

The oxide of zinc thus precipitated is to be washed with a large quantity of water, to free it as perfectly as possible from chloride of calcium: it may then be used instead of metallic zinc for the purpose of decomposing fresh portions of common salt.

The patentee says he would remark, that the oxide precipitated from the solution of chloride of zinc, containing sixty-four parts of the metal, being used instead of the same quantity of metallic zinc, a little allowance should be made for the loss unavoidable in the process. Or the oxide may be employed as a pigment, or in the manufacture of glass, or for any other purpose to which it is applicable.

It will be evident that the native carbonate of zinc and also sulphate of zinc may be used instead of metallic zinc and the above-described oxide of zinc; but they have not been found to be so advantageous under common circumstances—still he claims their use as part of his invention.

The patentee says, in conclusion, "I wish it to be understood that I do not confine myself to the use of any particular apparatus hereinbefore mentioned; nor do I claim any privilege with respect to such apparatus, nor the preparation of the muriatic acid. And I do not claim lime as a precipitant of zinc, nor the producing hydrogen gas from the decomposition of water. But I claim as my invention the use and application of zinc in any form in the decomposition of common salt, and in the manufacture of sulphate of soda; I also claim as my invention the producing of hydrogen gas during the decomposition of muriate of soda; and lastly, I claim as my invention the chloride of zinc as produced during the decomposition of muriate of soda. And I would remark, that I do not intend to confine myself to the proportions here stated, as other proportions may be used, but not with such advantage."

Lond. Jour. Arts & Sci.

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*Specification of a patent granted to MILES BERRY, of the county of Middlesex, for an invention of a new and improved method or process of alloying metals by cementation, particularly applicable to the preservation of copper, wrought or cast iron, and other metals; thereby operating a change in the appearance of their surfaces and giving them more brilliancy; being a communication made to him by a foreigner residing abroad.—[Sealed 3d May, 1838.]*

Alloying or changing of metals by cementation is a process well known in metallurgy, but I am not aware that any metal has ever been before so changed or protected by this process, that it could resist the action of air or humidity, or of certain acids; whereas, copper and iron, both wrought and cast, and other oxidizable metals, when they have been subjected to the said process, according as the same is modified to suit each particular description of metal, will be found to resist all these sources of oxidation.

And first, as regards copper, after it has been well cleansed, it is placed in a furnace, covered with a mixture of charcoal and powder of zinc, and the temperature then raised to cherry red, which degree of temperature is kept up for a longer or shorter period, according to the bulk of the article, or to the desired thickness of the coating and color to be given to the article. The operation is one of great nicety, for which I am informed no definite rules can be laid down, but, that experience will enable any competent workman to effect it with sufficient exactness. It will be found, that in every case, there is a point at which the copper when taken out of the furnace is perfectly inoxidizable, whereas, if the operation lasts too long, the product is nothing but common brass, very readily oxidized.

Second, with respect to iron: for the protection of this metal, two parts of zinc and three parts of copper are melted together in a crucible or any other suitable vessel, and into this mixture or alloy, the piece of iron after being well cleaned, is plunged. If bulky, the article is heated before it is dipped into the crucible, and the better to exclude the atmosphere, the zinc and copper bath is covered with a layer of sal-ammoniac, or melted rosin, or borate of soda, or other suitable substance, preferring however, the sal-ammoniac, which is found in practice to answer better than any other interposed medium.



The process thus described is occasionally reversed, that is to say, a boiling solution of the sal-ammoniac, or of borate of soda, is prepared, and the iron dipped therein before immersing it in the zinc and copper bath, but I am not advised to recommend this process as preferable to the other.

The article being prepared by one or other of these methods, is put into a layer of charcoal powder in a furnace, and exposed to a strong red heat, until the fumes of zinc begin to abate. It is not well to wait until the vapours indicate no longer any zinc. The quicker the operation, the better is the result. The piece of iron must be taken out of the furnace still covered with charcoal, and in that state plunged into water, or allowed to cool slowly.

A third modification of the process is as follows:—an alloy is made of zinc and copper in the proportions aforesaid, namely, two parts of zinc to three parts of copper, and when cooled it is put into a mortar with a quantity of borax, and pulverized. The iron well scoured and cleaned, is then smeared over with fat, oil, grease, or other unctuous substance, or merely wetted with water, and when thus prepared it is dipped into the zinc and copper powder, whence it is taken to be plunged into charcoal powder, and subjected to a strong red heat as hereinbefore directed, until the fumes of zinc begin to abate.

A fourth variety of the process is to dip the iron into a solution of sulphate of copper (after being perfectly cleaned), and to suffer it to remain there for a time. As soon as the iron is covered with a sufficient coating of precipitated copper, it is taken out, plastered over with potters' earth mixed with water, and then covered with a layer of pulverized zinc and borate of soda, or other substitute for the same; or the pulverized zinc and borate of soda or other substitute may be made into a paste, with the clay and water, and the article smeared over with the said paste. The iron is then placed in the furnace, covered with charcoal powder, and heated to a white heat for some minutes. The rest of the process is the same as before described.

The metals thus rendered inoxidizable, are either of a gold or silver hue, according to the length of the operation or the quantity of zinc that combines with the copper. The brightness of the gold colored alloy may be enhanced by rubbing the article with vegetable charcoal, or the soot from a wood fire and nitric acid. It is proper to add, that instead of pulverized zinc, I have been informed pulverized calamine may be used.

And having now fully specified all that has been disclosed or is known to me of the said process, I declare that I claim as new the process of alloying by cementation as hereinbefore described in its several varieties, by which copper, iron, and other oxidizable metals are preserved from oxidation, their surfaces are changed in appearance, and also rendered more brilliant.

*Ibid,*

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*To ORLANDO JONES, of the county of Middlesex, for improvements in the manufacture of starch, and the converting of the refuse arising in or from such manufacture to divers useful purposes.*—[Sealed 27th February, 1839.]

These improvements in the manufacture of starch and in the converting of the refuse arising in or from such manufacture to divers useful purposes, consist in the following modes of operating:—

Firstly, I have discovered that the introduction of saccharine matter among the farinaceous materials employed in the manufacture of starch is beneficial in promoting the vinous fermentation; secondly, that the introduc-

tion of yeast or other ferments among the materials in such manufacture will also assist the vinous fermentation; and thirdly, that acetic acid may be usefully employed for dissolving and separating the gluten from the secula in starch-making.

Though saccharine matters obtained from various substances would answer the purpose of my improved process, yet I prefer that obtained from the wash or refuse slime resulting from the manufacture of starch, which I prepare in the manner hereinafter described, and apply it with the meal, flour, or farinaceous material, whilst they are undergoing the steeping process. Yeast or other ferments may be added to the meal, flour, or other farinaceous materials, when steeping in the vat, the liquor being at a temperature of about 65° Fahrenheit. The acetous acid, in whatever way produced, I apply either by steeping the meal or flour in it in the first instance, which will supersede the necessity of a subsequent vinous fermentation, or it may be applied after the vinous fermentation has ceased, for the purpose of dissolving and separating the gluten from the meal, flour, or other farinaceous materials.

In order to convert the refuse wash or slime into saccharine matter or sweet liquor, I boil the said wash or slime with acid in the following proportions, or nearly so:—To any given quantity of the wash or slime, I add from one-twentieth to one fortieth by measure of the ordinary sulphuric acid of commerce, according to the state of the wash, which can only be known from observation. Such mixture I boil from two to four hours, dependent upon the strength of the acid and the state of the wash; and after this has been done, I introduce as much chalk or lime, or other suitable alkali, into the liquor as will neutralize the acid, and when settled, draw off the sweet liquor, which is then fit for use. Or I warm one hundred gallons of the before-mentioned wash or slime in a vessel to the temperature of from 76° to 86° Fahrenheit, and add to this from two to four bushels of finely-ground malt, and after well stirring it, raise the temperature of the mixture to 150° or 160° Fahrenheit. In this state it must continue from one to two hours, when the sweet liquor may be drawn off for use.

This saccharine matter or sweet liquor, thus obtained from the manufacture of the starch, I apply to promote the vinous fermentation in starch-making. Or the same may be fermented into distillers' wash, and subjected to the process of distillation for the production of alcohol; or it may be allowed to pass into the acetous fermentation, and be converted into vinegar.

Also, the top liquor resulting from the vinous fermentation of the meal, flour, or other farinaceous materials in the manufacture of starch, either in the improved or the ordinary mode, may, when the vinous fermentation has ceased, be drawn off for distillers' wash; or it may be allowed to pass into the acetous fermentation, and be converted into vinegar.

More particularly to describe my improvements in starch-making, without intending to confine myself precisely to the quantities of the materials used, I will say, for example, take four hundred gallons of water and add eighty gallons of sweet liquor, and warm the whole, and when at 65° F. stir in one hundred bushels of meal, flour, or other farinaceous materials; to this add from ten to fifteen gallons of yeast, or any other fermenting matter sufficient to set it in active fermentation; then stir it, that the whole may be equally fermented; and when the vinous fermentation has ceased, draw off the top liquor, from which may be extracted the spirit by distillation, and add four hundred gallons of strong acetic acid to the meal, flour, or other farinaceous materials remaining after the top liquor has been drawn off.

Stir this occasionally for three or four days; then wash it through sieves into a receiver, using acetic acid or water for that purpose; it must then be allowed to deposit, and after drawing off the acetic acid, separate the slime or wash from the starch, which may be washed and finished in the usual way of starch-making.

Should the slime or wash still contain starch, add acetic acid, and well stir and allow it to deposit; after which, the slime or wash should be drawn off, and the starch finished as usual.

Or I may vary the process, by taking four hundred gallons of acetic acid, cold, or warmed to 65° Fahr., and add one hundred bushels of meal, flour, or other farinaceous material, and stir it well occasionally for two, three, or four days, after which it may be washed through sieves and finished as above. Again, I may vary the process by taking four hundred gallons of water, cold, or at 65° Fahr., and adding one hundred bushels of meal, flour, or other farinaceous material, and allowing it to remain till the vinous fermentation has ceased: then draw off the top liquor (from which may be extracted the spirit by distillation), and add to the meal, flour, or other farinaceous material remaining after the top liquor has been drawn off, four hundred gallons of acetic acid warmed to 65° Fahr., or cold, and stir it well together. After remaining from two to four days, I wash it through sieves and proceed as already described.

Having thus explained my improvements in the manufacture of starch, and in the converting of the refuse arising in or from such manufacture to divers useful purposes, in such a way as I think will be perfectly understood by starch-makers, I lastly declare, that the novelties which I claim to have invented in respect to such improvements are, firstly, the introduction of saccharine matter among the meal, flour, or other farinaceous materials employed in starch-making, to promote fermentation and expedite the process; secondly, the employment of yeast or other ferments for a similar purpose; thirdly the use of acetic acid, to promote the acetic fermentation and to dissolve and separate the gluten in the process of starch-making; fourthly, converting the wash or slime obtained as a refuse product from starch-making to the purpose of producing a sweet liquor, which may be employed for the making of sugar and other uses, and particularly for promoting the vinous fermentation of the meal or flour in starch-making, or as a wash from which alcohol may be distilled; or it may be subjected to acetous fermentation, and converted into vinegar; and fifthly, the top water which is obtained from the vinous fermentation of the meal or flour, and the employment of the same as a distillers' wash for the production of alcohol, or for manufacturing acetic acid.

Ibid.

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**Progress of Practical and Theoretical Mechanics and Chemistry.**

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*Heath's Improvements in the Manufacture of Iron and Steel.*

Mr. Heath's invention consists, first, in the extraction of pure cast iron from the ore, without the intervention of any earthy, alkaline, or saline matter, to form a vitreous flux, cinder, or slag; second, in producing cast steel by fusing the pure cast iron so obtained, along with malleable iron or certain metallic oxides, in such proportions as may decarburate the cast iron to a certain degree; and in carrying the process of decarburation to the farther extent desired, by cementation with metallic oxides, without any admixture



of carbonaceous matter; third, in the use of oxide of manganese, without mixture of any other substance, in the process of converting cast into malleable iron, by the process of puddling; and, fourth, in the use of carburet of manganese to make common blistered steel into cast steel.

Malleable iron is at present produced either by smelting the richer iron ores with just as much charcoal or other carbonaceous matter as is adequate to abstract all the oxygen from the ore, and bring the ore into the malleable state; or by smelting the poorer ores, called "iron stones," in contact with carbonaceous matter, in such excess as to form with the metal the compound called carburet of iron by chemists, and cast iron by manufacturers; and then separating the carbon by a distinct and subsequent process. By the first process, malleable iron of very unequal quality in its different parts is produced; and by the second process a cast iron is obtained, which is contaminated to a very considerable degree with sulphur, phosphorus, arsenic, silicon, aluminum, calcium, and other foreign substances. A pure native oxide, or carbonate of iron, is alone capable of producing a pure metal convertible into good steel; but such pure ore has been hitherto debased and deteriorated in the smelting, by mixture with earthy, saline, or alkaline matters, under the name of fluxes, added with the intention of promoting the reduction of the metal, and of protecting it when reduced from the oxidizing influence of the blast.

After an extensive course of experiments, Mr. Heath has discovered that such earthy fluxes are not necessary. His operation is commenced by charging the blast furnace successively with coke, charcoal, or other suitable fuel, leaving the tap hole open, that the flame of the fuel, urged by the blast, may play in all directions, so as to bring the whole interior of the furnace into a uniform state of incandescence. When the furnace is thus charged, the tap hole is closed, and 20lbs. of ore are thrown into the furnace for every 100lbs. of fuel. The furnace is charged at this rate for about twelve hours, when the melted metal is run off into pigs. After this first discharge or casting the ore is added at the rate of 25lbs. for every 100lbs. of fuel, for a second period of twelve hours, when a second casting of pig iron is run off. After this second discharge, ore is added at the rate of 30lbs. for every 100lbs. of fuel during a third working period of twelve hours, and thus in each successive period of twelve hours, the quantity of ore is increased at the rate of five per cent. of the weight of the fuel, till eventually the proportion of ore amounts to about 65lbs. or 70lbs. for every 100lbs. of fuel. By proceeding in this way, and by throwing in the ore merely reduced to the size of peas, or thereabouts, but not roasted, if the furnace be well attended to by the workmen, it will turn out about 50lbs. of pure pig iron for every 100lbs. of fuel consumed.

To convert the carburet or cast iron thus produced into steel of any degree of hardness, it is melted in a cast iron or cupola furnace, by the heat of coke or other fuel; but, in all cases, no more fuel is used than is requisite to melt the iron, so that the oxygen of the blast shall serve to burn away the carbon of the carburet in a considerable degree, while a further portion of the carbon is neutralized or removed by the addition of scraps of metallic iron, or by the oxides of iron or of manganese.

To produce a superior cast steel from the pure cast iron, sesquioxide of manganese, or peroxide of manganese, which has been previously ignited, is introduced in quantities not exceeding five per cent. into the cupola: no more fuel is used than the blast can readily burn into carbonic acid, otherwise the excess of the carbonaceous flux would deoxidize the manganese,

nullify its decarburating action upon the cast iron, and thus prevent it from reducing the metal to that lower stage of carburet which constitutes cast steel. Sometimes, for the same decarburating purpose, a portion, not exceeding five per cent., of chrome ore may be used. When the decarburating has been carried in the cupola to the proper pitch, the steely metal is to be run out, and cast into iron moulds. The ingots thereby formed, are now to be converted into steel of any desired degree of mildness, by a further process of decarburating, which consists in stratifying the said ingots along with peroxide of iron, or peroxide of manganese, without charcoal, in a steel cementing furnace, which should be lined with sheet iron, if it is constructed of fire bricks or stone, to prevent the action of the peroxides upon the stone or bricks of the furnace. The ingots are to be here subjected to a cementing heat for a certain period, proportional in duration to the softness required in the metal.

Mr. Heath further improves the quality of malleable or bar iron, by adding to the pig or plate iron in the puddling furnace, while in fusion, from one to five per cent., or thereabouts, of any pure oxide or manganese, the sesquioxide being preferred.

An improved quality of cast steel is made, by putting into a crucible bars of common blistered steel, broken as usual into fragments, along with from one to three per cent. of their weight of carburet of manganese, and exposing the crucible to the proper heat for melting the materials, which are, when fluid, to be poured into an ingot mould in the usual manner.

London Mech. Mag.

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*Destructive Combination of Iron and Lead. By W. A. KENTISH.*

There is not a square, and scarcely a house that is not surrounded with iron railings, and these are pretty universally fastened in at the lower extremity, by lead. This combination of *iron and lead* keeps up so strong a *galvanic* action through the medium of the oxygen of the air, that the rails are, in a very moderate time, eaten away at the junction of the two metals, which must yearly entail an enormous loss that might easily be prevented.

The *iron*, in this instance, becomes the *protecting* metal, and thus *preserves the lead from decomposition*, which never could have been originally contemplated.

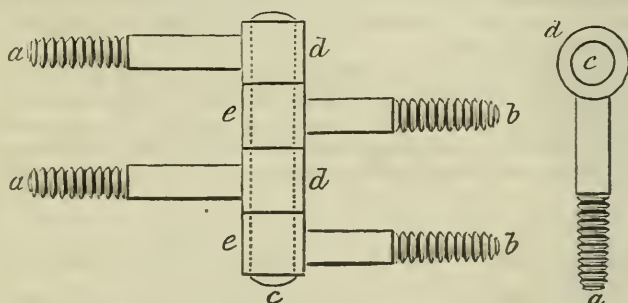
Now, if instead of using the lead, which is thus thoughtlessly rendered an inveterate enemy to the rails, we were to substitute *zinc*, for instance, this galvanic influence would then become *inverted*, the whole of its action would fall on the *zinc*, and the iron would be *preserved*, and as the zinc is oxidated with difficulty, it would, at the same time, be scarcely acted on; the one remaining uninjured, and the other nearly so.

*Paint*, formed of the *oxide of zinc*, for the same reason, would preserve iron exposed to the atmosphere, infinitely better than the ordinary paint which is composed of the *oxide of lead*. In some instances of late years, iron coverings have been used instead of stone. The rails are inserted in a square hole that just fits the bars, the unsightly method of filling up with lead is avoided, and all parts of the iron expand and contract equally in heat and cold. Whereas, with stone, the humidity in winter insinuates itself into the cavities round the fittings, and as it freezes, and so increases in volume, it bursts the stone coverings in all directions.

Ibid.

*Edward's Improved Hinges. Patent dated April 3, 1839.*

This is a very neat and ingenious improvement upon the ordinary hinge. The hinge is divided into a number of socket joints, each socket or division having a stalk attached thereto, or forming one piece therewith, by which to fix it to the door or door-post,—lid or box, for which the joint is to be formed. The sockets, or divisions, are to be fixed (either by screwing them in, or putting them through holes and tightening with a nut,) alternately one in the door, and the next in the door post, and so on. Thus, suppose the stalks and sockets, *a d*, to be screwed in to the door post,—and the stalks and sockets, *b e*, into the door, the pin, or pivot, *c*, passes down through the four sockets, and thus forms the hinge joint. Care must of course be taken to place the divisions at accurate distances from each other, so as to make the holes in the different sockets coincide. Any length of hinge may thus be formed, by multiplying the number of divisions. For dressing cases, desks, and similar kinds of articles it is particularly applicable.



The specification describes various methods of fixing the sockets, and some modifications of the hinge to suit particular cases, but the foregoing explanation fully exemplifies Mr. Edwards' invention.

*Ibid.*

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*Pattison and Losh's Mode of Making Oxides of Lead and Antimony. Patent dated April 3, 1839.*

Messrs. Pattison and Losh state their invention to consist in producing oxides of lead and antimony by first reducing these metals to the state of chlorides.

The broken lead ore is to be put into a wooden vessel lined with lead, then muriatic acid, of the strength of 1.10, is to be poured thereon. The vessel is closed air-tight—and the heat of steam applied until the whole of the ore has been reduced to the state of chloride of lead. The sulphuretted hydrogen evolved in this process, when sulphuret of lead is operated upon, is to be conveyed from the vessel by a pipe or other suitable means. The chloride of lead is then to be dissolved in hot water, and lime, cream of lime, or other earthy matter, is to be thrown into the solution, by which the oxide of lead will be precipitated: about 60lbs. of unslaked lime are necessary to 100lbs. of chloride of lead. By this process the sulphur of the ore is obtained in a state fit for use. Where the oxide is to be used as "blue lead," it must be submitted to the action of heat in a reverberatory furnace as with the oxide obtained by the usual process.



Antimony is to be treated in a similar manner to that described for lead. The chloride of antimony having been obtained, and dissolved in water, antimony itself will be precipitated; or if oxide is desired, about 60lbs. of unslaked lime is necessary to every 90lbs. of chloride of antimony. *Ibid.*

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*Important Invention in the Manufacture of Paper Hangings.*

We were favoured a few days since with an opportunity of visiting the extensive paper works of Messrs. J. Evans and Co., at the Alder Mills, near Tamworth, where we had the pleasure of witnessing the application of an ingenious and very beautiful piece of mechanism, the invention of the Messrs. Evans, to the printing of paper hangings, which cannot fail to produce a complete change in this department of our manufactures, from its superiority over the ordinary method of block printing. The Messrs. Evans would have brought their invention into practical operation many years ago, had it not been for the heavy duties imposed on the manufacture of stained papers, which, by limiting the consumption, rendered their invention comparatively useless, a fact which supplies another argument against the imposition of heavy duties upon the manufacturing skill and industry of the country. In connection with the present invention, we may here state that the Messrs. Evans took out a patent in February last, for an important improvement in the manufacture of paper, by the application of a pneumatic pump in the compression of the moisture from the pulp, by which means the substance is almost instantaneously converted into paper. By this invention they are, we understand, enabled to manufacture a continuous sheet of paper six feet in width, and nearly 2,000 yards in length every hour. This paper, as it is taken off the reel, is in every respect fit for immediate use, and is conveyed on rollers to another part of the mill, in which the printing machinery is erected, through which it is passed with great rapidity, and receives the impression of the pattern intended to be produced, with all the precision and beauty of finish which machinery can alone effect. In order to connect the operations of the paper making and printing machines, the Messrs. Evans are at present engaged enlarging their premises, and when this alteration is completed they will be enabled to print, glaze, and emboss, the most complicated and delicate patterns in paper hangings, in every variety of shade or colour, as rapidly as the paper can be manufactured. Some idea may be formed of the power of the machinery, and the importance of the invention, when we state that during our visit to the mill, the machinery was working at a rate which would produce 1,680 yards of paper per hour, consisting of two very beautiful patterns, the only hand labour employed being that of one man, who superintended the machinery, and four girls, employed in rolling up the paper in pieces of the required length. The whole process of manufacturing the paper from the pulp and impressing it with the most complicated patterns, is carried on within a comparatively small space, and with a precision and rapidity which affords another instance of the progress and triumph of science and mechanical skill, in supplying the necessities and comforts of civilized life. We understand it is the intention of Messrs. Evans to exhibit some specimens of their beautiful manufacture at the forthcoming meeting of the British Association, and we feel confident that amongst the many objects of interest which the mechanical skill and industry of Birmingham afford, the present will excite not the least interest or gratification. We may, perhaps, here observe, that the Messrs. Evans have also executed a very ingenious design of an envel-

ope, which seems admirably adapted for meeting the views of government in the contemplated change about to be made by the adoption of Mr. Rowland Hill's plan of a uniform penny postage. Specimens of this design have been forwarded to the Chancellor of the Exchequer for examination, and from the security which it affords against any successful attempt at forgery there appears great probability that it will be in part, if not wholly adopted.

*Midland Counties Herald.*

Civ. Eng. and Arch. Jour.

### *Connexion of Geology with the Arts.*

We extract the following passages from the "Report of the Council of the Royal Institution of South Wales," recently published, and obligingly forwarded to us:—

"In reviewing the transactions of the year which has just expired, there is a subject, which it gives the council much pleasure to place before the meeting, namely, the recent establishment of a scientific intercourse with an institution of a very important description, powerfully promoted by the government of the country, which has sprung into existence in the metropolis, under the title of 'The Museum of Economic Geology.' The immediate aim of this establishment is to make the researches of philosophy available to the pursuit of the useful arts. The foundation of it is well worthy the support of an enlightened nation, and, under proper management, it cannot fail to become the source of valuable information to commercial enterprise, and a school of instruction in all those branches of industry, on the healthful growth of which the happiness and prosperity of this great kingdom mainly depend. To the inhabitants of a mining and manufacturing district its importance readily suggests itself, and they naturally become anxious to participate, with as little delay as possible, in the benefits it will yield. Influenced by a desire to make these available to their own institution, the council addressed to Mr. De la Beche (who, under the direction of the Commissioners of woods and forests, superintends the practical details of the museum in question), an expression of their sentiments on the subject, and they are happy to find that, from the intercourse proposed, advantages are likely to flow that will prove mutually beneficial. It naturally must happen that the opportunities of a well-regulated provincial institution will be ample in its own immediate neighbourhood, and in a district such as the southern part of Wales, which, for mineral wealth and manufacturing industry, yields to none, the facts that come before it, whether illustrative of the materials its mines produce, and its population work into form, or of the state and condition of the arts by which those materials are extracted from the earth and devoted to use, must be of considerable value to a society instituted for the purpose of applying science to the economic objects of life; while, on the other hand, the wide range and powerful means of the metropolitan society, bringing a collection of materials from a multitude of sources, will enable it to effect an extensive and instructive diffusion of the knowledge it obtains, and thus repay what it receives from one locality with the information it derives from another."

Mining Jour.

### *Barnett's Improved mode of working Gas Retorts.*

Sir,—I herewith forward you a description of a new mode of working gas retorts which I have had in successful operation here for some time. I shall

be much obliged by your publishing it in your Magazine, which has already distributed a great deal of information upon the subject of gas manufacture.

By adopting my improved method, about from 2,600 to 2,700 feet of gas, more than by the ordinary method, can be produced from a ton of coals, whatever the kind of coal may be. This increase of gaseous product is effected by the longer time which the material is kept subject to the influence of the heat, so that a great portion of the tar and ammoniacal water is decomposed. The gas produced is also of a greater illuminating power.

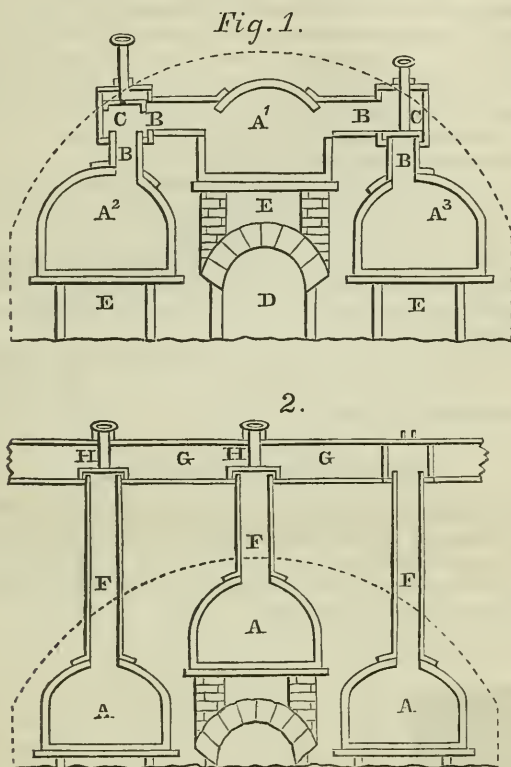


Fig. 1, is a sectional front view of a retort bed with three retorts. There may however be any desirable or convenient number. Fig. 2, is a sectional back view of the same retort bed. AAA are the retorts, which communicate with each other by means of the pipes B B B B. C C are two hydraulic valves, by which the communication between any two retorts may be cut off. Where three retorts are connected, two of them only need have valves—but where more than three are used every retort must have a valve. D, the position of the furnace, which communicates with the ovens E E E by means of small flues or apertures from the furnace. In fig. 2, A A A are also the retorts; F F F, the pipes leading to the gas main G G. This communication may be closed by means of the valves H H.

The mode of operation is as follows: The retort A¹ is charged; one hour and a half afterwards the retort A² is charged; and one hour and a half af-



ter that, the retort  $A^3$  is charged; in one hour and a half more the retort  $A^1$  is ready to be recharged; the coal having undergone the usual process of six hours subjection to the heat of the furnace; and so on in succession alternately, each retort being submitted to the action of the fire for the same time. In the retort  $A^1$  (supposing the operation to be in full action,) the first hour and a half or quarter time of the charge, the dense volatile matter and ammoniacal water of the coal is set free, and passes into the retorts  $A^2$  and  $A^3$ , where, in connection with the carburetted hydrogen which  $A^2$  is producing, and the sulphuretted and carburetted hydrogen which  $A^3$  is producing, it is further distilled. Each retort will thus in succession be performing the stage of operation here represented. Previously to a retort being charged, its communication with the other, and with the main  $G$  must be cut off, by the valves  $C$  and  $H$ ; and one retort only—that is to say, the one of the three (or any other series used) which has been longest subjected to the action of the heat,—must communicate with the main.

The figures are but roughly drawn, and all the parts except those relating to my improvement, are in skeleton. The exterior dotted lines represent the outline of the brick setting of the retort bed.

Should you think this invention of mine of sufficient importance for publication, I shall be happy to send you descriptions of other contrivances relating to the same subject, which I have at various times made, experimented upon and worked.

I am your obedient servant,

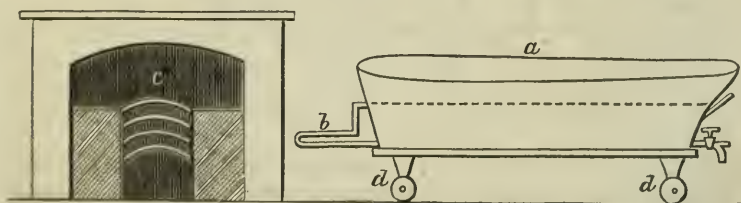
WM. BARNETT.

Brighton, November 15, 1839.

Lond. Mech. Mag.

#### *Economical Portable Hot Bath.*

Sir,—The following novel plan of heating a bath was communicated to me by Mr. Le Croix, of Upper Norton street, New Road, Regent's Park, whose idea it is; and thinking from its simplicity, it deserved being made public, I respectfully offer it for insertion in your valuable pages, if you think the plan merits a place in them.



In any room with a grate  $c$ , a fire is to be made, the bath  $a$  filled and wheeled towards it, being fitted on large castors  $d$  to move readily; the tube  $b$  attached to the bath, which is adjusted to the height of the bars is then inserted between them; in a short time the water will be heated to the degree required, when it may be wheeled to any part of the room without the least annoyance.

G. M. BRAITHWAITE.\*

Ibid.

\* We should be glad to receive from the readers of our Journal an account of any mode of heating a movable bath, which they may think preferable to the foregoing.  
G.

## Progress of Physical Science.

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*Experiments to determine the Fluency or Viscidity of Different Liquids at the same Temperature, and of the same Liquids at different Temperatures. By DR. URE.*

Having been employed professionally, Dr. Ure observed, to investigate the operation and merits of a new lamp, recently patented by Mr. Parker, in which the oil is heated by the flame of the lamp to the temperature of from 200° to 250°, before arriving at the wick, it was desirable to determine the degree of fluency imparted to oils by a certain elevation of temperature. The light emitted by this lamp, when supplied with the viscid, and very cheap, but nearly scentless, southern whale oil, surpasses in purity and whiteness the light of the best mechanical lamp, though it be fed with the best vegetable or even sperm oil. This superiority is in part due to the form of the chimney, and to the oil being maintained uniformly at the level of the bottom of the frame; but it must also be ascribed, in a certain measure, to the high temperature and fluency of the oil, by which it enters more readily into complete combustion, than cold and viscid oil could possibly do. The preparatory heating seems to act on the same principle here, as it does in the smelting of iron by the hot blast. Having presented a memoir upon the subject of the lamp to the Society of Civil Engineers, which will appear in their transactions, I shall decline entering at present further into its merits. In that memoir, I stated the results of some experiments which I had then made upon the fluency of liquids, by means of an apparatus, consisting of a small glass syphon, and a platina capsule, containing a measured quantity of the liquid to be run off through the syphon. Having since had reason to imagine that certain numerical errors had been occasioned by variations in the position of the syphon, though the general results are true, I have recently repeated the experiments with another form of apparatus free from that fallacy, and submit the following brief account of them. Upon this occasion I put the liquid, either cold or heated to a certain temperature, into a glass funnel, terminated at its beak with a glass tube of uniform bore, about one-eighth of an inch in diameter, and three inches long. The funnel was supported in a chemical stand, and discharged its contents, on withdrawing a wooden pin from the beak, into a glass goblet placed beneath, alongside of which a chronometer was placed to indicate, in seconds, the time of efflux. The volume of liquid used in each case was the same,—viz. 2,000 grain measure, at 65° Fahr. The times of efflux with liquids of the same specific gravity and bulk, in the same vessel, vary with the viscosity of the liquids, and serve to measure it. A correction ought to be introduced in estimating the times of efflux of hot liquids, on account of the enlargement, by expansion, of the bore of the glass tube; but this, being a point of little consequence in the practical application of this inquiry, has been neglected.

|                                   |            |            |         |
|-----------------------------------|------------|------------|---------|
| 2,000 grain-measures of water, at | 60° Fahr., | ran off in | 14 sec. |
|                                   | 68         |            | 13      |
|                                   | 164        |            | 12      |

When the funnel and glass tube were faintly smeared with oil, though perfectly pervious, and apparently clean, boiling hot water having been run through them:—

|                                   |                        |         |
|-----------------------------------|------------------------|---------|
| 2,000 grain-measures of water, at | 150° Fahr., ran off in | 24 sec. |
|                                   | 142                    | 23      |
|                                   | 94                     | 24      |
|                                   | 56                     | 25      |

So great is the repulsive influence between oil and water, in retarding the flow of the latter through a small orifice.

| 2,000 grain-measures of            | Fahr. | Spec. grav. | Sec. |
|------------------------------------|-------|-------------|------|
| Oil of turpentine . . . . .        | 65°   | 0.874       | 14   |
| Pyroxylic spirit . . . . .         | "     | 0.830       | 14   |
| Alcohol . . . . .                  | "     | 0.830       | 16   |
| Nitric acid . . . . .              | "     | 1.340       | 13½  |
| Sulphuric acid . . . . .           | "     | 1.840       | 21   |
| Ditto . . . . .                    | 262   |             | 15   |
| Saturated solution of sea salt     | 65    | 1.200       | 13   |
| Sperm oil . . . . .                | "     | 0.890       | 45½  |
| Fine rape-seed oil . . . . .       | "     | 0.920       | 100  |
| Fine pale seal oil . . . . .       | "     | 0.925       | 66   |
| Fine South Sea whale oil . . . . . | "     | 0.920       | 66   |
| Sperm oil . . . . .                | 254   |             | 15   |
| Rape-seed oil . . . . .            | 254   |             | 17   |
| South Sea oil . . . . .            | 250   |             | 17   |

The rape-seed oil is so viscid, as to burn with difficulty in lamps of the ordinary construction, but in the hot oil lamp of Parker it affords a very vivid light. In my former apparatus, the difference of level between the two legs of the syphon, which constituted the effective pressure of efflux, was only half an inch, whereby 2,000 grain measures of sperm oil, at 64°, took no less than 2,700 seconds to run off, while that volume of oil of turpentine ran off in 95 seconds. It would, therefore, appear that the fluency of a viscid oil diminishes in a very rapid ratio with the diminution of pressure. Hence, an oil will burn well in a mechanical lamp, where it is raised to the level of the bottom of the flame by pump work, which will afford a very indifferent light in one of the French Annular or Sinumbral lamps, where the supply is given by a very slight pressure.

Prof. Forbes asked what was the diameter of the orifice of the funnel through which the fluids ran, and what was the quantity of each fluid experimented upon.—Dr. Ure said, that the orifice had a diameter of one-eighth of an inch, and the quantity of each fluid used was 2,000 grains.—Prof. Forbes said, that the interest he felt in these experiments arose from the great importance, in some of the researches he was engaged in, of sustaining the action of the lamp in an unchanged state during the progress of an experiment, and sometimes during a series of experiments; but the changes to which even the best ordinary lamp was subject were so anomalous, and the causes so beyond the reach of discovery, as to be quite disheartening. The instrument that he used for measuring minute changes of temperature was so delicate, that the heat given out by even an apparently well-burning lamp, often appeared to be in a constant state of change, the needle indicating it by an almost constant oscillating motion of even several degrees; even lamps, whose wicks were made with the greatest care, were subject to these changes; and the only wicks which he had found to furnish a sufficiently steady temperature for his purposes, were those made by Locatelli, of Paris.



*Proceedings of the British Association. Divisibility of Matter.*

The President said, that as one or two papers had been withdrawn, he would proceed to make some remarks on Dr. Wollaston's argument respecting the infinite divisibility of matter, drawn from the finite extent of the atmosphere.—He observed, that Dr. Wollaston had proceeded on this supposition; that if the extent of the earth's atmosphere be finite, air must consist of indivisible atoms; since, as he assumed, the only way in which we can conceive an upper surface of the atmosphere is, by conceiving an upper stratum of atoms, the weight of which, acting downwards, is balanced by the repulsive force of the inferior strata acting upwards.—Mr. Whewell maintained, that such a mode of conception was altogether arbitrary, and the argument founded upon it quite baseless; for if we investigate the relation between the height of any point in the atmosphere, and the density of the air at that point, upon the supposition that the compressing force is as the  $n$ th power of the density, we find that the density vanishes at a finite height whenever  $n$  is greater than unity. Therefore, though the atmosphere does not consist of indivisible particles, it will still have a finite surface. In fact, the finite surface of the atmosphere no more proves the atomic constitution of air, than the finite surface of water, in a vessel, proves the atomic constitution of water. But it will still be asked, how then is the highest stratum of air supported? To which the answer is, that there is no highest stratum of definite thickness. Supposing the atmosphere finite, every upper stratum of air bounded by the upper surface of the atmosphere, has the upper part of that stratum supported by the lower; and, however thin it be, it has still an upper and a lower part which have this relation to each other. The question, What supports the *uppermost* stratum of the atmosphere? is of the same kind as the question formerly discussed by writers on mechanics: What is the velocity with which a body *begins* to fall?

Professor Stevelly said that perhaps this question would be more familiar to many persons if the scientific language of the President were made more popular, by explaining, that the real question was, whether matter was so constituted as to be infinitely divisible? or consisted of molecules or atoms, which could not be farther divided, *de facto* at least; for in imagination any portion of extension, however small, can be farther subdivided. This latter, Wollaston produced strong probable reasons for considering as the true statement; his argument from astronomy was, that if matter were capable of indefinite subdivision, the atmosphere would be indefinitely extended, and then the moon and planets would, each, in the lapse of time, have collected atmospheres from ours, bearing to one another the proportions of their power of attraction; this was not the case, as astronomy proved: for instance, the density of the atmosphere of the moon was not the 2000th part of that of the earth, at their respective surfaces. The earth's atmosphere then did not even extend, in space, as far as the moon.—Dr. Daubeny said he was sorry to find, that the doctrine of atoms, which on chemical grounds, he considered as probable, had been deprived, by the President, of the support which the memoir of Dr. Wollaston had seemed to afford it. He had been disposed to think more favourable of that argument, from finding that M. Dumas had resorted to a very paradoxical supposition in order to reconcile the conclusions of Wollaston, which he admitted, with the doctrine of the infinite divisibility of matter, which he also maintained. M. Dumas, in his work '*Sur la Philosophie chimique*,' maintains, that a limit

would be assigned to the extent of our atmosphere in consequence, merely, of the extreme cold of the upper regions, by which the air would be condensed into a solid form. Hence, according to him, the boundary of the atmosphere would consist of a sort of *crystalline sphere*, such as what the ancients had imagined, but with this difference, that the celestial luminaries according to Dumas's views would lie beyond the sphere, whereas Ptolemy supposed them to be included within it. Leaving it for opticians to decide how far such a palpable medium could interfere with the transmission of light and heat from without, Dr. Daubeny contended, that the temperature which Fourier had assigned to the celestial spaces was too high to allow of the solidification of oxygen and nitrogen gases, which indeed had been found to resist a degree of artificial cold greatly inferior to this, as, for instance, that produced by solid carbonic acid. But though he could not agree with Dumas in this particular point, he was quite ready to bear his testimony to the general merits of his work, and in particular, to point out the satisfactory manner in which he has shown, that matter cannot be separated into its ultimate particles, either by physical or by chemical means; but that elastic bodies consist of *groups of atoms* mutually repulsive, and that chemical combination takes place between smaller groups indeed of the same, but not between individual atoms.

Ibid.

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*On the Crystallization of Carburets.* By S. BROWN, M. D.

The object was to lay down a new form of the maxim of crystallization—viz. That when the particles of a solid body are slowly evolved from the decomposition of a substance of which it, or its elements, are chemical constituents, they cohere in crystals, and that independently both of the fusion (or solution) of the body crystallized, and of the presence of any fluid medium or molecular motion whatsoever. This principle the author deduces from a multitude of experiments. The principle is applicable to substances which are infusible and insoluble; and, indeed, as the title of the paper imports, has been inferred from observations made on such substances—viz. the metallic carburets, as produced by the decomposition of sulphocyanides and cyanides. The subjects of the experiments were the carburets of iron, copper, zinc, lead, tin, manganese, &c. These carburets are, in their amorphous form, dark and opaque, being not easily distinguishable from charcoal. By the use of the following formula, the author prepares these substances in transparent, colourless, and intensely hard little crystals. Formula:—Let a parcel of any cyanide or sulphocyanide be decomposed by heat, in exclusion from air, at that point of temperature which may be called its point of decomposition, and the resulting carburet is found to be of crystalline structure. It is a tedious process, requiring five hours for a drachm of cyanide of zinc. The author exhibited specimens of crystals procured in this way, especially of carburets of iron, which cut glass. The application of these facts and their principle to the explanation of certain mineralogical and geological cases of crystallization, as well as to the arts, the author left with the Section; but called attention to that point of view in which his labours are chiefly valuable; that they prove that the only essential condition of the crystallization of a body is, that its particles be slowly segregated from any previous condition whatever. In conclusion, he observed that the chemical identity of carbon and the diamond has been long established by inference. Now, there is as great a difference,—nay, exactly the same difference, between the

sensible properties of these carburets in their amorphous and crystalline conditions, as between the carbon of the destructive distillation of organic proximates and the *diamond*. The particles of carbon *may* be evolved from a matrix of which it is a chemical constituent; let them, in the terms of the general proposition, be evolved *slowly enough*, and they shall co-arrange themselves in the crystalline form of cohesion. In more pointed phrase, char wood with sufficient care, and you will obtain, not charcoal but crystallized carbon.

Athenæum.

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*Note on several new reactions determined by Spongy Platina, and considerations on the services this substance is required to render Science. By M. FRED. KUHLMANN.\**

Dœbereiner's beautiful discovery of the property which spongy platina possesses of determining the combination of a mixture of hydrogen and oxygen, has been justly regarded as one of the most precious facts acquired by science for a long time. Every one might foresee the extension that so extraordinary a kind of action would one day take, yet we are astonished at the few facts which have been observed since the date of Dœbereiner's labours, twenty years ago.

The numerous experiments, of which I am about to speak, appear to me likely to lead the attention of chemists to a too much neglected question, and which I look upon as the most fruitful in fine results.

1. Ammonia mixed with air, in passing to a temperature of 300° surrounding spongy platina, is decomposed, and the azote which it contains is completely transformed into nitric acid at the expense of the oxygen of the air.

2. Cyanogen and air under similar circumstances give rise to the same acid and carbonic acid.

3. Ammonia engaged in any saline combination acts as if it were free.

4. In no case has pure azote been able to be combined with free oxygen, but every compound of azote under the influence of the spongy platina passes to the state of nitric acid.

5. Protoxide and deutoxide of azote, hypo-nitric and nitric acid, mixed with a sufficient quantity of hydrogen, are transformed to ammonia by their contact with the platina sponge, and very often without the assistance of heat. The action becomes so energetic that it frequently causes a violent explosion.

All the azote of these oxides or acids passes to the state of ammonia by uniting with hydrogen.

An excess of nitric acid gives a nitrate of ammonia.

6. Cyanogen and hydrogen give ammonia in a hydrocyanate state.

7. Deutoxide of azote in excess and olefant gas in becoming hot on the platina sponge, produce, besides water and azote, ammonia united to the hydro-cyanic and carbonic acids.

8. With deutoxide of azote and an excess of alcoholic vapour we obtain under the same circumstances ammonia united with hydro-cyanic and carbonic acids, and accompanied with water, olefant gas, and a deposit of coal.

9. We have not been able to combine free azote with free hydrogen, but all the compounds of azote have been transformed into ammonia by free or carbureted hydrogen.

\* From the Comptes Rendus, 24th December, 1838. Translated by Mr. J. H. Lang.



10. In these latter reactions the presence of carbon in combination with azote or hydrogen, produces hydro-cyanic acid.

11. All the gaseous or vaporizable metallöides unite without exception with hydrogen under the influence of the spongy platina.

12. The vapours of acetic acid mixed with hydrogen are totally transformed into acetic ether (acetate of ether) and water, by the action of platina sponge at a slightly elevated temperature.

It is a very remarkable fact that by substituting the platinum black for the platina sponge, the energy of action is infinitely less in most cases, contrary to what we might expect. This action is even nullified for producing nitric acid; for producing ammonia it is very feeble, and the platina black never enters into incandescence as is the case with the sponge. For the transformation of acetic acid into ether, the action of the platina black is, on the contrary, more lively, and produces it at the ordinary temperature.

Sturgeon's Annals.

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## Progress of Civil Engineering.

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*On the application of Anthracite Coal to the Blast Furnace, Steam-engine boiler, and Smith's fire, at the Gwendraeth Ironworks near Carmarthen.*

By MR. PLAYER.

The inconvenience of the fire choking, for a long time baffled the experiments made on the subject, but it was at last obviated by heating the coal before it reaches the fire, which was accomplished by supplying it, without any mixture of coke or bituminous coal, through a perpendicular chamber placed centrally on the top of the boiler with an opening about 20 inches in diameter immediately over the fire-place. In passing through this chamber, by its contact with the plates, the coal acquires considerable heat, and descending by its own gravity, as the fire consumes beneath, replaces what has been burnt, by which means a regular supply of fuel is furnished, fit for immediate and complete ignition. Another inconvenience is also thus avoided, as fresh coal thrown upon the fire abstracts a quantity of heat from the fuel already in ignition, and checks the generation of steam. The fire is never meddled with; there are no fire drawers; there is no current of cold air passing through the flues, and a very small amount only of draught is required. One engine worked seventy-two hours consecutively, during which time the grate neither choked nor clinkered; nor was a bar used for the fire, or did there remain any considerable result in ashes. The coal was, in this instance, entirely anthracite, (small, but not powdery) and tipped into the feeding chamber once every 4 hours. Water was also kept in the ash pit, the steam from which, being decomposed by passing through the fire, the gas forms a jet of flame, creating another active source of power. On these works, there are in action upon this principle, five smith's fires, the tool-maker's fire being blown by a thirty inch bellows only, whilst with this the largest squaring edges for the masons are made with ease. The coal is supplied through an upright brick flue, about three feet six inches high, two feet six inches long, and nine inches wide. The foundry has similar arrangement, with merely the addition of a flue to take off the flame, the blast being cold, and worked by a small water-wheel, and by which iron is re-melted, running very fluid, and yielding an excellent quality. An oven has also been built for the use of the workmen, heated only with small culm, which succeeds admirably.

Athenæum.

*Proceedings of the British Association. On the relative Combinations of the Constituents of Cast Iron, Steel, and Malleable Iron. By DR. CHARLES SCHAFHAEUTL, of Munich.*

The author showed, that the purest carbon contained and retained hydrogen, and sometimes azote, even at the highest temperatures, and parted with neither of them, nor were its own internal and external properties altered, except when it attacked the crucible, and combined instead with oxygen, or aluminum, or silicon. He affirmed, that we possessed no certain method of procuring pure carbon in the isolated state, and that what we considered to be pure carbon was always, more or less, in the state of *carburet*. The author described a new method of obtaining graphite—viz. by running fluid puddling slag, or silicates of iron and manganese, over fragments of pit coal. After cooling, the surface of the slag is always found to be altered, and to be covered with a very easily separable layer of graphite, not only where the slag actually touches the coal, but even where it comes in contact with the smoke evolved from the coal. The formation of graphite commences at a temperature lower than 1500° Fahr., and reaches its highest point not much exceeding 2000°. Two different sorts of graphite were produced in this way; one, which he marked graphite (A), was in elastic scales, of the thickness of writing paper, with a rather dull metallic appearance. The graphite marked (B) was of the thickness of gold leaf, and extremely light and unctuous to the touch. He found, that all sorts of graphite lost their unctuousity and bright appearance by exposing them to the action of concentrated hydro-fluoric acid gas. Graphite (B) was found to consist of—

|                    |         |
|--------------------|---------|
| Protoxide of iron, | 18.6000 |
| Silica,            | 7.6200  |

Probably mechanically, but equally and invisibly intermixed with

|          |                |
|----------|----------------|
| Carbon,  | 70.3421        |
| Silicon, | 3.0744         |
| Loss,    | 00.3635        |
|          | <hr/> 100.0000 |

Graphite (A) gave—

|               |
|---------------|
| 4.93 Silicon. |
| 9.50 Iron.    |
| 85.45 Carbon. |
| 00.12 Loss.   |
| <hr/> 100.00  |

The quantity of oxides of iron and silica had been ascertained by heating the specimens first with acids and caustic leys; the quantity of carbon, by burning the specimens with chromate of lead and chlorate of potash; and the silicon, by melting the powders with carbonate of soda in a platinum crucible. He considered, therefore, the graphite to be a *carburet of silicon* and iron; and showed, by heating in a *peculiar way* the remainders, left after the solution of iron in chlorohydric acid of a certain specific gravity, that the chemical composition of cast iron, in its two distinct species of gray and white cast iron, had direct relation to the two specimens of graphite, and in

all probability was derived from similar origin, as indicated in following table:—

| <i>Graphite (B).</i> |                             | <i>Gray Cast Iron.</i>  |                                 |
|----------------------|-----------------------------|-------------------------|---------------------------------|
| Iron                 | } Oxygen. Silicate of iron. | Iron                    | } Silicet and aluminet of iron. |
| Silicon              |                             | Silicon                 |                                 |
| Silicon              | } Carburet of silicon.      | (Aluminum)              | } Carburet of iron.             |
| Carbon               |                             | Carbon                  |                                 |
|                      |                             | Silicon                 |                                 |
| <i>Graphite (A).</i> |                             | <i>White Cast Iron.</i> |                                 |
| Iron                 | } Carburet of iron.         | Iron                    | } Carburet of iron.             |
| Carbon               |                             | Carbon                  |                                 |
| Carbon               | } Carburet of silicon.      | Azote                   | } Carburet of silicon.          |
| Silicon              |                             | Silicon                 |                                 |
|                      |                             | Carbon                  |                                 |

It was further shown, that all gray iron, produced by heated air, as well as by cold air, left a grayish white residue behind after treating it with chlorohydric acid of a certain specific gravity. This remainder, acted upon with caustic ammonia, evolved very rapidly pure hydrogen gas, and alumina afterwards was found in the solution with a little silica. The presence of aluminum in its metallic state, after having been treated with acid, as well as the absence of all *azote*, seemed to be one principal feature of *gray iron of France* as well as of England; as, on the contrary, carbon, hydrogen, and *azote* are always present in the remainders of *white iron*, which remainders appear invariably of a brownish colour; and that *azote* was a constituent of steel as well as of wrought iron. Further, it was explained, that silicon generally was combined with *carbon*, and dissolved in the carburets of iron, and that it was extremely difficult to produce an alloy of iron with silicon alone, without the presence of a little carbon, aluminum, and other similar bodies. He found the molecules of all iron of a similar form, belonging to the cubical system, and the largest not exceeding 0.0000633 of an inch in diameter, and that particularly upon the arrangement of these molecules depends, in a great measure, the different appearance of the different kinds. He denied that any graphite scales were to be seen in gray cast iron; yet, that under the magnifying glass what appeared to the naked eye graphite scales, were really surfaces and planes of crystallization, composed of pentagonal planes not wider in the smallest diameter than 0.000355 of an inch, and composed of the before-mentioned smallest or primitive iron molecules. According to his statement, the molecules of the iron are arranged in the gray cast iron in the most regular form, having all their surfaces in one plane; the most equal distribution of molecules appeared in hardened steel; collecting in fascicular aggregation in soft steel, and being loose and longitudinally arranged in wrought iron. He stated that pure iron could not be welded; that the welding power of iron depended on its alloy with the carburet of silicon, and also that the good and various qualities of all the wrought irons depended on the alloys of pure iron with other metallic bodies; and that the presence of most of the electro-negative metals had been generally overlooked in the existing analysis of iron. The presence of arsenic in Swedish steel, when forged red hot, could be ascertained by its smell, as well as in the Low Moor iron. The usual solution of iron under analysis, in order to separate these metals from the iron, must be, for the



necessary correction, divided into two parts,—one to be treated with a current of sulphuretted hydrogen, the other part *dropped* into sulphydrate of ammonia, and carefully digested. A small quantity of silica was more difficult to separate from a large quantity of iron than generally seemed to be believed; and the real amount of carbon could *only* be ascertained by Berzelius's method of burning iron in a current of oxygen, or mixed with chlorate of potash and chromate of lead in a glass tube, used first by Berzelius for analysis of organic bodies. The author maintained that steel was an entirely mechanical production of the forge hammer, which tore the molecules of certain species of white cast iron out of their original position, into which the forces of attraction, in respect to the centres as well as to the position of the molecules, had arranged those molecules of the slow action of heat. Steel, as it came out of the converting furnace or the crucible, was nothing more or less than white cast iron, of which Indian steel, called Wootz, was the fairest specimen. The author finally gave an analysis of two specimens of cast iron and one of steel. The first specimen was French gray iron, from Vienne, Department de l'Isere, obtained from a mixture of pea-iron-ore with red hematite, by means of coal from Rive de Gier and heated air, specific gravity 7.898. The second iron was Welsh iron, from the tin-plate manufactory of the Maesteg Ironworks, near Neath, in South Wales, obtained from a mixture of clay iron-stone and Cumberland red ore, by means of coke and heated air. It was silvery white, without signs of crystallization: specific gravity 7.467. The third specimen was a fragment of a razor forged in the author's presence, in the workshop of Mr. Rodgers, of Sheffield, of the specific gravity of 7.92.

|            | Gray French Iron. | White Welsh Iron. | Steel.    |
|------------|-------------------|-------------------|-----------|
| Silicon    | 4.86430           | 1.00867           | 0.52043   |
| Aluminum   | 1.00738           | 0.08571           | 0.00000   |
| Manganese  | 0.75130           | traces.           | 1.92000   |
| Arsenic    | 0.00000           | 0.00000           | 0.93400   |
| Antimony   | 0.00000           | 1.59710           | 0.12100   |
| Tin        | 0.00000           | 0.00000           | traces.   |
| Phosphorus | 0.54000           | 0.08553           | 0.00000   |
| Sulphur    | 0.17740           | 0.32018           | 1.00200   |
| Azote      | 0.00000           | 0.76371           | 0.18310   |
| Carbon     | 0.38000           | 4.30000           | 1.42800   |
| Iron       | 89.00740          | 91.52282          | 93.79765  |
| Loss       | 00.27222          | 00.31428          | 0.09382   |
|            | 100.00000         | 100.00000         | 100.00000 |

Several gentlemen, among whom were some connected with the iron trade, expressed a high sense of the value of this communication, from which it appeared that the peculiarities of Swedish iron, in a great degree, depended on the presence of arsenic, and those of Russian iron on the presence of phosphorus.

Ibid.

*Observations on the present mode of executing Railways, with suggestions for a more economical, yet equally efficient system, of both executing and working them.* By FRANCIS WISHAW, M. Inst. C. E.

The author at the commencement of this paper alludes to the principal causes of the great differences between the original estimate and cost of railways. Among these he enumerates the imperfect knowledge of the strata, which occasions the cuttings and embankments to be formed with slopes, which are dangerous, and add to their cost—the imperfect formation of the embankments, especially in clayey soils, which in the opinion of the author ought to be carried up in layers or courses of from  $1\frac{1}{2}$  to 2 yards in thickness, sufficient time being allowed for subsidence before the next layer is added—the cost of stations, which in some of the great lines forms a considerable proportion of the whole cost.

The author then proceeds to suggest means for effecting a considerable saving in the original cost of railways, a certain method of preventing accidents by collision, a saving in the annual expenditure, and a better adaptation of the locomotive engine to its work.

With these views, he proposes a single line of rails—that the line should be divided with intermediate engine stations, three on the London and Birmingham for instance, the engines at each being suited to the prevailing gradient of the district. Thus a line of railway may be more easily laid out, as one or two unfavourable inclines will not affect the working of the whole. At each station there must be a small portion of an additional line of rails, and also at other convenient intervals. The mode of working such line is as follows:—Engines are to start simultaneously in each direction from the terminal and intermediate stations. These engines will pass each other at one of the portions of the double line, and the engine being reversed and taking the other train, will return to the station from whence it started, when another exchange of trains takes place. Thus there is a regular interchange of loads throughout the day, and each engine is confined to its own portion of the line, and it is impossible that a collision can take place. Equal accommodation would be afforded to the public, and the engine man, from being always confined to the same small portion of the line, would be perfectly conversant with every part of it. The saving which would on this system be effected on the original cost is estimated at more than £5000 per mile.

Lond. Jour. Arts & Sci.

*On the Marquis of Tweeddale's Patent Brick and Tile Machine.* By Mr. G. COTTAM.

The first process by this machine is to make a continuous sheet of well-pressed clay, of the proper breadth and thickness. This is then cut into the required lengths. It moulds at the rate of 24 bricks per minute, or 1,440 per hour, and, in a brick-maker's day of 16 hours would produce 23,040 per day; and, in consequence of the compression which the clay undergoes, the bricks do not require one-third of the time to dry them that the hand-made bricks do. The tile machine is a modification of that of bricks. In each case, the clay is made to pass between two rollers, from whence it is brought out in a thin flat cake, and is cut to the requisite width by two wires. It is then conveyed, by an endless web, under other rollers, and, by a simple contrivance, the tiles are cut to the required size, the web farther conveying them on to the shelves from whence they are taken to be burnt. By a modification of the

machine, the drain-tile and the pan-tile can be manufactured with equal facility.

In a subsequent conversation, Mr. Cottam mentioned some experiments which had been made on the power of absorption possessed by these bricks in comparison with those made by hand. One of the latter being put into water for six hours, absorbed 28 oz. of water, while a machine-made brick absorbed but 4 oz. Their solidity had also been compared, and this was also much in favour of the machine bricks, the weight of one of which was 8 lb. 19 dr., whilst one of the hand-made bricks of similar size was but  $5\frac{1}{4}$  lb. There is now a manufactory in full operation at York, where about 15,000 per week were produced. The endless web on which the clay ran was moleskin cloth, or velveteens, and which, from the numerous points which it presents, prevents adhesion.

Athenæum.

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*Royal Geological Society of Cornwall.*  
*Boring Granite Rocks.*

Mr. Pridaux observed, that a year or two since it had been suggested to him whether some chemical process could not be adopted to bore hard rocks. After some consideration, and trying several experiments, he at last found that a stream of hydrogen-oxygen gas applied to a piece of granite soon produced heat, and on the application of cold water the stone became soft, and yielded to the tool. He repeated the experiment with the same result in every case. Mr. P. then explained how the gases should be mixed, and how it might be infused into the hole in the rock. He also said that a great deal of the difficulty of getting the gas at the bottom of the mines might be obviated by very simple means. Oxygen might be superseded by common air from a pair of double bellows; and the common coal gas would be found better than hydrogen, because it contained more inflammable matter in a given space, and it might be procured from any neighbouring gas-works, and conveyed down into a mine in a copper vessel. (Mr. Prideaux explained the kind of vessel by diagram.) If, said Mr. Prideaux, oxygen gas should be found absolutely necessary, nothing was easier to procure where there was a steam engine; they had only to get a little iron retort, and in a county like Cornwall, abounding with manganese, they need never be at a loss for oxygen gas. He did not, however, suppose, in the present state of underground management in our mines, this plan would be adopted, but he was of opinion, should the Mining School be continued for two or three years, there would soon be many young men ready to carry it into effect.

Mining Review.

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*On Tubing the Boilers of Locomotive Engines.* By GEORGE BUCK, M.  
*Inst. C. E.*

In this communication, the author has attempted to determine the diameter of the tubes of the boiler of a locomotive engine, so that the effect in the generation of steam may be a maximum. The following are the conditions upon which the problem is solved: That the evaporating effect of the hot air, in passing through the tubes, is in proportion to the extent of surface in contact with the hot air, and as the time of contact conjointly. The following are the results of the investigation: The distance between the centres of two adjacent tubes should be equal to four times the interval between their internal surfaces—the diameter of each tube should be equal to three times the same interval—that the tubes should be as near each other as possible.



In illustration, Mr. Buck has drawn two sets of tubes of the locomotive boiler as generally employed, and one as they would be arranged according to the results of this investigation. On comparing the products of the aggregate periphery, and the aggregate area of the tubes, it appears that the boiler tubed according to the above theoretic proportion is from 23 to 26 per cent. superior to others.

Inst. Civ. Eng.

*On Mr. Smeaton's estimate of Animal Power, extracted from his MS. Papers.* By JOHN FAREY, M. Inst. C. E.

The amount of mechanical power has been frequently over-stated, in consequence of the conclusions being drawn from efforts continued for too short a time. Desaguliers estimated the power of a man as equal to raising 5507 lbs. one foot high per minute; this was found by Smeaton to be too high; several experiments are recorded, in which different values are assigned to the power of a man, and he ultimately fixed it at about  $\frac{2}{3}$ ds of the above, or 3672 lbs. Several experiments are recorded of the estimate of the power of a horse, and of the quantity of water raised by various machines.

The communication is accompanied by a letter in Mr. Smeaton's handwriting, dated 21st Feb. 1789.

Ibid.

## Mechanics' Register.

### *The Daguerreotype.*

One great obstacle to the use of M. Daguerre's photogenic process, is the difficulty of preserving the pictures when completed, because they are of so delicate a nature, and so easily injured, that the slightest touch effaces them—even M. Daguerre himself has always found it necessary to protect them with a plate of glass, which is both inconvenient and troublesome; and it has, in consequence, been suggested, that if a varnish could be discovered which might be easily applied to the surface of the plates after the completion of the pictures, and which, whilst it protected them from injury, should not impair their delicacy, it would considerably add to the value and usefulness of the process:—we are happy, therefore, to hear, that M. Dumas has discovered, that a liquid, composed of one part of *dextrine* and five parts of water, forms a varnish of the desired nature. It is said to be well adapted for the purpose, and further possesses the advantage of being easily removed from the surface of the picture, by immersing the whole in boiling water. Time, however, will be required to ascertain whether this varnish has any action on the peculiar mercurial compound of which the image is formed.

Athenæum.

### *Zarskojeselo Railroad.*

At a general meeting of the shareholders in this railroad, lately held at St. Petersburg, it appeared by the report of the directors that the cost of the formation of the road and its *matériel* had amounted to 5,281,667 roubles. The original calculations were founded upon the anticipation of 300,000 passengers within the year, but, during the preceding twelve months, the number of travellers between the capital and Zarskojeselo had amounted to 500,000, and the number which passed along the whole line to and from Paulowsk was 707,091. The receipts amounted to 920,237 roubles. At the end of the first nine months the receipts exceeded the expenditure by 316,976 roubles. Of this balance 90,000 roubles were applied in paying the in-

terest and reimbursing the loan from the Crown; and 140,000 roubles to the payment of interest on shares; 15,848 roubles were divided, according to the statutes, among the directors; 1555 roubles were paid to the chief engineer; and 69,572 roubles were carried to the reserved fund.

Mining Jour.

### *Magnetic effect of Lightning.*

[Extract of a letter from Malta.]

After the mainmast of H. M. S. *Rodney*, was struck by lightning during her late passage from Athens to this place, the broken hoops surrounding it were all found to be magnetized, in the same uniformity of direction as if they had been operated on in one direction also by the galvanic helix. Thus, in a hoop broken in two athwart-ships (speaking with reference to the ship's head,) the larboard end of the foremost portion was a south and its starboard a north pole; the end of the aftermost portion in contact with the south pole of the foremost portion being, consequently, a north pole, and the other end thereof a south; and so uniformly with all the other hoops, at whatever part they were broken; similar poles in each hoop always pointing in similar directions in the circumference of the respective circles.

Athenæum.

### Notices.

*Proposed exchange of Minerals.*—The subscriber has recently made a large collection of the minerals of Nova Scotia, formerly discovered by Dr. Jackson and himself, and is desirous of exchanging suits of them for the minerals of other regions, foreign or domestic. The specimens have been selected with great care, are of good size, and generally well crystallized, often uniting in the same specimen several different species. They comprise nearly all the species of the Kouphine spars of Mohs and Haidenger; rhomboidal or uncleavable quartz; most of the varieties of quartz, agate, jasper, amethyst, &c., besides many interesting ores, salts of lime, &c., &c. By referring to the 14th and 15th volumes of Silliman's Journal, or to the 1st volume, new series, of the Transactions of the American Academy, a particular notice of these minerals will be found, in a memoir on the Geology and Mineralogy of Nova Scotia.

Those persons who may wish to exchange are requested to forward to the subscriber, in Boston, a list of such mineral as they may wish to dispose of, before sending the specimens, as his cabinet is already well supplied, and it is his wish to select such, principally, as are not already contained in it.

FRANCIS ALGER.

*Boston, Mass. February 1st, 1840.*

*Manual of Chemistry.*—In the press of March, Capen, Lyon, and Webb, Boston, An abridgment of Webster's Manual of Chemistry, (recently published) for the use of schools and academies. Also OUTLINES OF MINERALOGY, by Thomas Thomson, M. D., with alterations and additions by Prof. J. Webster. Intended as a text book for persons attending lectures, &c.

The communication of new localities of American minerals is particularly requested, addressed to the publishers in Boston.

*American Repertory.*—A new monthly periodical under the above title, and devoted to Arts, Sciences, and Manufactures, has been commenced in New York, under the Editorship of Prof. Jas. J. Mapes, who is advantageously known as a gentleman of science, and practical skill.





### Hygrometer.

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

SEPTEMBER, 1839.

[illegible]



**JOURNAL**  
OF THE  
**FRANKLIN INSTITUTE**  
OF THE  
**State of Pennsylvania,**  
AND  
**MECHANICS' REGISTER.**

MARCH, 1840.

**Practical and Theoretical Mechanics and Chemistry.**

*History of the Steam Engine, with a reply to the Criticisms to which the first publication of the article gave rise. By M. ARAGO.*

[From the Annual of the Board of Longitude, for 1836.]

TRANSLATED BY LIEUT. A. A. HARWOOD, U. S. N.

[CONTINUED FROM PAGE 87.]

*Safety Valve.*

The fire placed under the boilers of large engines, is never regulated with sufficient uniformity to prevent the steam, which they contain, from acquiring, now and then, a higher degree of elasticity than that which they are capable of resisting. To prevent this inconvenience and the dangerous explosions which would ensue from it, is the object of a little apparatus which is very appropriately named *a safety valve*.

The safety valve was invented by Papin. It formed an essential part of his digester, and may be found described in pages 6, 7, 8, 9, and 10 of a small book, printed in Paris, in 1682, entitled "*La Manière d'amollir les os, etc. etc.*"\* Papin's contrivance is precisely identical with the safety valves most commonly used in our time. His principle, moreover, is very simple.

\* The following paragraph will be found in Robison's history of the steam engine, with notes by Watt, p. 48. "Dr. Papin, a Frenchman, invented about that time (about 1699,) a method of dissolving bones and other solid animal matter in water, by enclosing them in perfectly tight vessels, which he called digesters. These matters acquire, in this way, a great degree of heat. I ought here to observe that Hooke, the most acute experimenter of an age so fruitful in ingenious research, *had discovered* A LONG TIME BEFORE, *that is to say, in 1684*, that water, when heated in the open air could not exceed a certain degree of temperature, and that as soon as it began to boil



The object is to avoid subjecting the boiler to too violent pressure from within. To effect this, a very small portion of its side is cut out circularly, and the hole which is thus made is covered with a neatly fitted plate, movable from within outwards, just as if the corresponding portion of the boiler were movable itself. Suppose, for instance, the hole to have a surface of a square inch. Papin calculated then to how great a pressure a square inch of the boiler would be exposed, when the elasticity of the steam should have attained the prescribed limit; in this way the weight with which the valve should be loaded is determined, so that it shall not be lifted by any pressure below this limit, and that, on the contrary, it shall be raised, and give free vent to the steam whenever the limit in question is exceeded. This plan would present some difficulties if the opening of the valve being great, the pressure should require to be powerful; the weight with which it would then be necessary to load it would become considerable and difficult of adjustment; Papin, therefore, preferred working the movable plate by means of a lever. In that case a moderate weight is sufficient to counterbalance the greatest pressure. This weight suspended successively from notches made in the lever at various distances from the centre of rotation, like the weight of a steel-yard, graduates the various degrees of pressure, and enables the machinist to charge them so as to suit the kind of work in which he is employed. I have entered into details concerning Papin's safety valve, because the apparatus itself is of extreme importance, preventing, in a great measure, disastrous accidents from explosions, to which boilers were inevitably exposed before its adoption, and because it affords me a new opportunity to render our countryman a tribute of justice which has too long been withheld.\*

At the time when explosions of digesters showed that a common safety valve could not be trusted, without danger, to inexperienced hands, a plan was hit upon to furnish these utensils with a piece which *must inevitably act of itself* as soon as the temperature should be too high. For this purpose an alloy was selected, known to chemists by the name of *fusible metal*, and composed of bismuth, tin, and lead. A portion of this alloy fitted in a hole made in the pot, melted, and left the aperture open, as soon as the steam acquired too great an elasticity, or, what is the same thing, too high a temperature. These fusible plates are now applied in France to all the boilers of high pressure engines, and the law requires their use. The degree of fusibility of the plates varies according to the proportion of the different metals which enter into their composition, and is always regulated before hand according to the degree of elasticity which the constructor certifies that his engine is capable of sustaining.

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Hitherto I have only spoken of steam engines which have stood the test

it always marked the same degree." In order that this passage should be exact, *La Manière d'amollir les os* must have some other date than 1682; but as 1682 is actually the true date of Papin's work, Dr. Robison's *long time before* should be read, *some time afterwards*. Arguments borrowed from arithmetic are irresistible.

\* Partington affirms in his interesting work that Savery's first engines were provided with a safety valve; but it is a mistake: no trace of it is found in the figure inserted in the 21st chapter of the Philosophical Transactions. Allowing it to be as stated, Papin would, nevertheless, be the true inventor, since his *patented* description is dated 1682, and Savery's patent goes no further back than 1698, and the first trial of his engine before the Royal Society took place in 1699. (Philos. Trans., vol. xxi, p. 238.)

of long experience. I had intended to devote a few pages to engines which only exist, so to speak, in theory; such as rotary engines, those to operate by hydrogen gas, and by liquified gas, etc.; but the great length which this article has already attained obliges me to postpone the notice of them. For the same reason I also suppress the detailed discussion which I had intended to give of the best shape of boilers and furnaces; the probable causes of the frequent explosions in boilers; the best effects produced by the most perfect engines known; those which future modifications may probably produce, judging by the known properties of steam. If the excursion I have made out of the region of Astronomy and Meteorology, the ordinary subjects of the notices in the *Annuaire*, does not appear out of place, I may perhaps complete this article in the next number. Meanwhile, I conclude by a succinct recapitulation of the various consequences which appear to me to flow from it.

1615. Solomon de Caus was the first to think of employing the *elastic power of Steam*, in the construction of a hydraulic draining machine.

1690. Papin conceived the possibility of making a steam engine with a piston.

1690. Papin was the first to confine, in the steam engine operating with a piston, the elastic power of steam with the property of condensation by cold.

1705. Newcomen, Cawley, and Savery were the first to perceive that to condense steam rapidly the water injected for that purpose must be forced in small drops into the very midst of the steam.

1769. Watt pointed out the great advantages in point of economy to be gained by substituting his method of condensation in a separate vessel for the method hitherto followed of effecting that operation in the cylinder itself.

1769. Watt was the first to point out the advantages to be derived from cutting off the steam in working an engine.

1690. Papin was the first to propose the employment of steam engines to turn axles or wheels, and pointed out a method for the purpose. Up to his time, steam engines had been considered as only applicable to purposes of draining.

1690. Papin proposed the first double acting engine, but with two cylinders.

1769. Watt invented the first double acting engine with a single cylinder.

Before 1710, Papin had devised the first high pressure engine, without condensation.

1724. Leupold described the first engine of this description with a piston.

1801. We are indebted to Messrs. Trevithick and Vivian for the first high pressure locomotive engine.\*

1690. Papin must be considered the true inventor of steam vessels.\*

In regard to the principal components of a steam engine:

1718. Beighton invented the vertical rod or *plug frame*, moved by the working beam and opening and shutting the valves in large engines.

1758. Fitzgerald was the first to make use of a fly to regulate the rotary motion communicated to an axis by the steam engine.

\* The reader is requested to refer to our remarks on these heads.—TRANS.

1778. Washborough employed the crank to change the rectilinear motion of the piston into one of rotation.

1784. Watt contrived the jointed parrallelogram or parallel motion.

1784. Watt applied, with great advantage, to his various engines, the centrifugal force governor, already known before his adaptation of it to this purpose.

1801. Murray described and made the first slide valves worked by an eccentric.

Before 1710, Papin had invented the four-way cock, so important in high pressure engines.

1682. Papin invented the safety valve.

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*An examination of the critical observations which has been made upon the preceding memoir.*

The preceding *historical notice* was first published eight years ago. At that time the results which it contained differed too widely from the ideas generally received among our neighbours across the channel to allow me to flatter myself that they would not give rise to objections. Such objections were in fact made. At first they made a timid and anonymous appearance in obscure corners of the political papers. Soon, however, Mr. Ainger, an engineer, came forward, made a collection of them for which he became responsible, and out of which he composed a formal refutation. Mr. Ainger was little known to the scientific world; his name did not call to mind any work which commanded confidence. I had, therefore, every reason to suppose that the refutation of my memoir, announced moreover with a good deal of parade, would be judged impartially and according to its real merit. I think this was not the case: the *Quarterly Journal of the Royal Institution* opened its columns eagerly to him, enriched his remarks with numerous and beautiful wood cuts, and many lectures in the fine saloons of *Albemarle street*, supplied the unavoidable tardiness of the press; my defeat, finally, was stated in all quarters to be complete, irrevocable and humiliating: I had not quoted faithfully; my illustrations teemed with inaccuracies.

I had abstained, knowingly, from speaking of many authors, both ancient and modern, from which the French mechanicians must needs have derived their pretended inventions, etc. etc.

I did not think I ought to rest quietly under the weight of such grave imputations, and as soon as Mr. Ainger's article appeared, I refuted it. My antagonist had lost sight of the rules of common courtesy; I was weak enough to get angry at this, and to reply with a warmth, which, however great the provocation, could not become the pages of *l'Annuaire du Bureau des Longitudes*. No other proper means of publication occurring to me at the time, I threw my manuscript into a box, from whence, probably, it would never have emerged, but for the singular circumstance which I am about to relate.

I was going to give, lately, my sanction to the last proof sheet of the republication of my memoir, when I received from Dr. Mease, of Philadelphia, an article upon the steam engine comprising a part of the American edition of *Dr. Brewster's Encyclopedia*. This article contains, without any critical commentary, a part of Mr. Ainger's memoir; but, in the letter which accompanied it, Dr. Mease expresses his regret at not being able to procure my answer, and engages to introduce it in a supplement as soon as it shall reach him. A well informed person, and friendly towards me, deceived by



Mr. Ainger's confident tone, has attributed, then, some weight to his arguments. I confess that I did not believe it possible; I confess that I reposed with confidence upon these few words which an English *savant*, whom all the world will admit as a judge in such a case, addressed to me in 1834. "What you have endeavoured to establish in your history of the steam engine is to my mind mathematically proved." But since this conviction does not yet exist on the other side of the Atlantic, I have determined, for the sake of science as well as, why should I not avow it, for the sake of national glory, to disinter a writing which I had condemned to oblivion. I give it, moreover, as it was written eight years ago, with the exception of some suppressions, the reasons for which I have already hinted at. To speak frankly, I even fear that these suppressions have not been numerous enough, and that there may remain here and there a trace of the warmth of my first rejoinder; but I have not had time to make further alterations.

The criticisms of Mr. Ainger are of two kinds. In the first he reproaches me with a host of supposed errors, the guilt of which I might have incurred without altering the merits of the question in the slightest degree. The second are more serious in their nature, for if Mr. Ainger were in the right I should be greatly to blame for introducing French names into the history of the steam engine; these require minute examination. Let us enter at once into the details of the criticism.

The notice in the *Annuaire*, "has excited (says Mr. Ainger) more attention than might have been thought due to so hackneyed a subject. . . . The cause of that attention will, perhaps, be found in the preface by which the paper is introduced." An author is not responsible for the notice, whether deserved or not, which the public condescends to give to his works; therefore I might have refrained from noticing my critic's explosion of ill-humor, did it not furnish me with an opportunity, the only one I shall probably find in this article, of approaching to an agreement in opinion with him. Moreover the testimony which he has been kind enough to transmit me of the indulgence of the public, will account for the value I set upon proving that in default of all other merit, the article in the *Annuaire* possesses that of accuracy.

According to Mr. Ainger, I have charged "all the English writers (one only excepted) with having sacrificed the truth to their national prejudices." That this assertion has no foundation requires no other proof than this single passage. "When Messrs. Young, Robison, Partington, Tredgold, Millington, Nicholson, Lardner, etc., introduced the Marquis of Worcester as the inventor of the steam engine, Solomon de Caus' works were, *without doubt*, unknown to them." If credit is not given to the sincerity of this declaration, I will observe that among the seven names just read, is that of an illustrious *savant* (Thomas Young) of whom science has been lately deprived by a premature death, and the advantage of whose friendship I enjoyed for many years.

Thus I have not said, I could not say that *all* the English authors, Mr. Stuart excepted, had knowingly deviated from the truth; the reader will in a moment decide for himself on the other hand whether these same authors have given proof of their impartiality.

According to Mr. Ainger the figure borrowed from Solomon de Caus of an engine for raising water by the action of fire, which accompanies the description in my memoir, is inaccurate: the ascending tube and the little pipe which serves to introduce the liquid into the metallic ball, are both too long

A second alteration consists in the suppression of the dilated sheet of water which terminates the ascending jet. I confess, that having no argument to offer upon the length of these tubes; I did not enjoin the person who copied the figure to preserve the proportions of the original drawing. As to the sheet of water, the engraver suppressed it to simplify his work. Mr. Ainger might have added that he has not figured the water in the ball and that the burning sticks placed under it do not perfectly resemble those of Solomon de Caus. I recommend these observations to his attention in case his pamphlet reaches a second edition. The extreme futility of the criticism just noticed ought not to prevent me from making a brief remark. I have no where announced either that Hiero's figure, or that of Solomon de Caus, were copied minutely or in exact geometrical proportion; thus Mr. Ainger exposed himself to severe observations when he said: "M. Arago gives the figure as an extract from the same work (that of Solomon de Caus)."

Observing that Mr. Ainger, in the article Savery, returns a second time to this lengthening of the tube, which he presents as an important alteration, and one made on purpose, I have had the curiosity to apply a compass to the tube in the figure given in the *Annuaire*, and to the jet figured in the work of Solomon de Caus; and it appears that the jet is nearly a third larger than the tube. Thus Mr. Ainger has reduced himself to the choice of an alternative, either to retract his abusive insinuations or to maintain that the power in virtue of which a jet of water rises in the air would not carry the liquid the same height in a tube. I would charitably persuade him not to make this choice until after having consulted a treatise upon hydraulics.

This elongation of the tube appears to have been a real windfall in Mr. Ainger's eyes. He makes the best of it in every way; he would not cut off a millimetre of it for a treasure, and yet the whole amounted to this, that it appeared to him very long, since he declares, page 330, that the two tubes are *indefinitely elongated*. I have just said that the tube is shorter than the jet in the original; thus, whatever malice may be exercised in the case, this fact must be recognized, that the alteration, if alteration there be, has not been made with the intention of adding to the power of the engine. If I had thought and I ought to insist upon the great height to which steam, in the apparatus of de Caus, could raise water, I should have shewn it not by a figure without a scale, but by reference to this phrase, already cited: "The violence is great when the water is converted into air by means of fire . . . it is certain that if the said ball (a copper ball containing water) is placed upon a large fire so that it may get very hot, it will cause so violent a compression that the ball will split in pieces."

In writing the history of the steam engine, I thought that the best way of fixing the attention of the reader would be to show, step by step, in what respect each new plan improved the engine already existing. It is in this way, for instance, that I have analysed all the improvements which Savery made in Solomon de Caus' engine. This method appears to have singularly displeased Mr. Ainger; to explain Savery's engine, and to explain it clearly without finding it necessary to resort to a figure, is quite shameful in his eyes; he does not say that the description is inaccurate or that it appears to him insufficient, and the sin of omission, therefore, with which he reproaches me was only conjured up by way of a make weight.

Whoever should entertain the idea of not limiting his responsibility to the strict signification of his words, and should be imprudent enough to extend it to the *consequences* which might be deduced from them, would find certain commentators who would soon make him repent his rashness. Two

little illustrations having appeared to me necessary to explain the ideas which directed Papin in the various attempts to which he devoted himself before he contrived the atmospheric steam engine, I placed them in the memoir published in the *Annuaire* at the head of the arguments of which they were, in some degree, the illustration. What does Mr. Ainger on this occasion? He says that these illustration being immediately under the title, *Denis Papin*, "the reader of course concludes are the description of Papin's invention; but," adds he, "it will hardly be believed that they are nothing of the sort, they are the descriptions of the apparatus of the Englishman, Newcomen, made fifteen years afterwards."

My answer will be very simple: as a general position I do not accept of the *conclusions* which the first-comer takes a fancy to draw from my words; I do not feel myself strong enough to resist this sort of attack; I will add in this particular case, that having nowhere said: "the two figures which I make use of are taken from Papin's works," it should affect me but little to have my critic cry out that they are not to be found there; but I have a perfect right to maintain that they are there, for the engine in which Papin proposed to cause a vacuum under the piston by the aid of a separate hydraulic wheel, is no other than that which I have given a drawing of, excepting this single modification; that the valve, or rather the cock, intended to admit the air, instead of being situated under the metallic plate which supports the cylinder, as in my drawing, is on one side at the end of a little horizontal tube issuing from the bottom of this same cylinder. If, profiting by the inexperience which the readers of a journal may have in the contrivances of mechanists, Mr. Ainger has pretended to establish the belief that such a displacement of the valve or cock had been made with the view of improving Papin's plan, I will remark that in modern engines the valve is never at the bottom of the cylinder and that it is always, as in the genuine illustration of Papin, upon the nearly horizontal tube which supplies the steam. M. Arago, says Mr. Ainger, "gives six pages to the description of this apparatus (Papin's,) in which *he brings the steam into the cylinder from the boiler*, through the valve *a*," (that of the lower plate.) I am really sorry that my antagonist so often obliges me to answer him by a simple denial; but in truth I cannot admit his version, as I said: "the water which furnished the steam in these first attempts, *was not contained in a separate boiler*, it was deposited in the cylinder upon the metallic plate which stopped it below." In the whole of the remainder of the article nothing more is said about the production of steam.

Papin proposed two kinds of steam engines. The first, that of 1690, is the engine with a piston, known, since its improved construction by Newcomen, by the name of the atmospheric engine; the other, described in 1707, depended upon different principles, and was simply intended for raising water. I have not room here to discuss the different criticisms of which this last engine has been the subject; I will grant then, if it is desired, that they are all well founded; but what of that? We can only conclude that Papin was more clever or more fortunate in 1690 than in 1707; that his mind was enfeebled by age; that at the second period of time the whole merit of the discovery which he had made seventeen years before, had ceased to be as vividly impressed upon his memory; but in what does all this weaken his right to the invention. Did Newton cease to be author of the *Principia* or of his *Optics* after he had written an inferior treatise upon chronology.

The trouble, therefore, that Mr. Ainger and other writers have given themselves to criticise the *second* engine (invented in 1707) is thrown away



Though Papin should have been crazy at the time, though he should have been confined in a mad house, his engine of 1690 would, nevertheless, remain the germ of all the steam engines in existence. Besides, it is not difficult perhaps to find a plausible motive for Papin's abandonment of his first project: it probably lay in the difficulty in casting and boring out the cylinders which he would have required. In 1695 this difficulty, which in our days has entirely disappeared, seemed to him so great that he proposed to establish a manufactory expressly for the purpose of making the tubes intended to compose the cylinders of such of his engines as should be made use of to propel vessels.

Mr. Ainger does not admit the doubts which I have raised respecting the interpretation hitherto given to a passage relative to the boiler which Worcester proposed to make use of. Want of space obliges me to submit to judgment by default in this case, although, if it were worth the trouble, I could cite one of the most celebrated English engineers in support of my opinion. The same motive prevents me from correcting one or two really singular mistakes into which Mr. Ainger has fallen in an irrelevant display of erudition on the subject of an experiment of Otto de Guerike.\* I hasten then to come to his great objections.

However slight the attention which may have been given to the working of a steam engine, two things of capital importance are apparent: in the first place the idea of employing the elastic power of steam as a principle of motion; secondly, the idea, not less important, of getting rid of this steam by condensation, as soon as it has operated.

Should the person, who first reflecting upon the prodigious elasticity which steam acquires when it is produced at a high temperature, have shewn that it might be used to raise great weights; he who has been the first to propose and describe an engine in which the elasticity of steam was the sole principle of useful operation in the arts; should this person, I repeat, be considered as the inventor of the steam engine? Such is the first question to which the history of this engine gives birth; and one which has been answered affirmatively in all the works with which I am acquainted. Thomas Young, Robison, Partington, Tredgold, Millington, Lardner, Nicholson, etc., are unanimous in this respect. For my part I have only adhered to the opinion of so many able natural philosophers and engineers, and differ from them but in one point: in England the discovery is generally attributed to the Marquis of Worcester, I maintain that it is due to Solomon de Caus, because this engineer's work contains the figure and the description of an engine intended to raise water by the action of steam; because the Marquis of Worcester's, of which moreover the form is not known, had precisely the same object, and because the little which is known with regard to it did not appear until 1663, forty-eight years after the publication of *La Raison des Forces Mouvantes*.

Here Mr. Ainger enters the lists, who also discovers an engine intended for raising water, in J. B. Porta, an author older than Solomon de Caus. If this be the case, the name of Solomon de Caus, which I have substituted for that of Worcester, ought, without doubt, to make way in turn for the name of Porta. Therefore I proceed at once to verify Mr. Ainger's assertion, without dwelling upon the singularity of the circumstance that the

\* We cannot consider this as an irrelevant display of erudition on the part of Mr. Ainger, as Otto de Guerike certainly did raise a weight by the descent of a piston before Papin had any such idea. That he made a vacuum under the piston by an air pump does not invalidate this claim.—TRANS.

name of the Neapolitan *savant* should never have been mentioned as long as Worcester enjoyed, without dispute, the title of inventor, and that it should have been called to mind as soon as it seemed to militate against the rights of a French author.

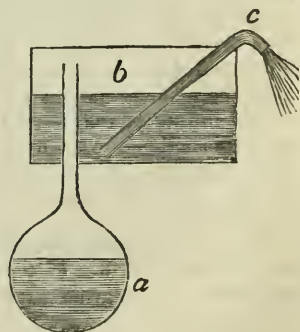
The Neapolitan philosopher's engine is found, says Mr. Ainger, "*in a translation of the work of Hiero of Alexandria, which was published in Italian by Baptista Porta, in 1606,*" (pages 326 and 327.) I read further on (page 344,) "The reader who wishes to verify the statements here given may consult the different editions of Hiero's *Spiritalia*, and especially the *translation in 1606, by Porta, entitled: I tre libri Spiritalia*, of which a copy is in the British museum."

When the article in the *Quarterly Journal* reached me, I had glanced over various editions of Hiero's work, but I did not know that of Porta which Mr. Ainger cites. At first I reproached myself for this negligence, but, upon investigation, assisted by our most celebrated bibliographers, it was discovered that the work in question does not exist; that, in fact, there is no translation of Hiero by Porta. This author, it is true, has published a work, *in latin* entitled, like that of the Greek mechanician, (*Pneumaticorum libri tres*, Naples, 1601, in quarto) but it is no more the work of Hiero than Buffon's natural history is a translation of Aristotle's. The *Pneumatics* of Porta, translated into Italian and Spanish by a person called Juan Escrivano, were published in 1606 with the title of: *I tre libri de Spiritali de Giovam. Battista della Porta Napolitano*, in a small quarto volume. This is the book which Mr. Ainger has taken for an Italian translation made by Porta, while it is actually by Juan Escrivano; for a translation of the Greek work by Hiero, while it is a translation of a Latin work by Porta. Mr. Ainger has succeeded in uniting upon this point all the errors into which it was possible to fall.

In the seventy-fifth page of Porta's *Spiritali*, published by Escrivano, is found the apparatus which Mr. Ainger cites as an engine for raising water by means of the elastic power of steam, as a great improvement of an engine by Hiero, of which I shall soon have occasion to speak. I will here give a translation of the chapter of Porta, or rather of the chapter of Escrivano, for it does not exist in the original, and it will then appear how far Mr. Ainger has brought his inventive genius into play.

"CHAPTER VII.—To know into how many parts a simple portion of water is transformed.

"Make a box of glass or tin, the bottom of which should be pierced with a hole, through which shall pass the neck of a bottle used for distilling, containing one or two ounces of water. The neck shall be soldered to the bottom of the box, so that nothing can escape there. From the same bottom shall proceed a pipe, the opening of which shall almost touch it, leaving just room enough between them for the water to run. This pipe shall pass through an opening in the lid of the box, and extend itself on the outside to a small distance from its surface, (passi per lo coverchio fuori poco lontano dalla sua superficie.) The box must be filled with water by a funnel, which is afterwards to be well closed, so as not to allow the air to escape, (che non



afterwards to be well closed, so as not to allow the air to escape, (che non

posso respiraré); finally, the bottle must be placed upon the fire and heated a little, then the water, changed into steam, will act violently upon the water in the box, and will make it pass through the pipe *c* and flow off on the outside. The water must be kept heated, in this way, until no more of it remains; and as long as the water shall smoke (*sfumera*) the air will press the water in the box, and the water will flow off on the outside. The evaporation being finished, you may measure how much water has gone out of the box, and there will remain in it as much water as shall have passed out of it, (the bottle) and from that you can conclude how much water has run out, and into how much air it has been changed. You may also easily calculate how many parts of lighter air an ounce of air of ordinary consistence is capable of giving."

Let us now recall the manner in which Mr. Ainger announces this passage.

"A translation, says he, of the work of Hiero's, was published in Italian, by Baptista Porta, in 1606, he repeats Hiero's invention, and adds the following of his own, illustrated by a diagram, in which is shewn the furnace for heating the water."

The truth is, that Porta does not speak at all of Hiero's machine; that he had no kind of intention of improving it; that he did not even dream of making an engine; that his aim, his whole aim, was to determine experimentally, and by a method, all the faults of which it is useless here to point out, the relative bulk of a given quantity of water, and of the steam into which it is transformed by heat. Porta had so little idea of proposing his apparatus as a fit one for raising water, that he says in formal terms that the pipe by which the water flows off passes to a small distance from the lid of the small box. I have no wish to deny that Porta was not ignorant that steam could propel a liquid in the same way as air; but nothing, absolutely nothing, proves that he had the least idea of the great power which steam is susceptible of acquiring, and of the possibility of employing it as an effective moving power. Porta, the most enthusiastic of contrivers mentioned in the history of the sciences, would not certainly have neglected to speak of this particular motion if he had ever entertained it. Moreover, the whole effect of Porta's experiment would have been equally produced, if his large bottle in lieu of water had only contained air.\*

The double idea that steam properly enclosed, raises water above its level, and that it is capable of producing the greatest effect; that therefore, it might be used in the construction of useful engines, is found, for the first time to my knowledge, in the work of Solomon de Caus. Perhaps something analogous to it may be found in older authors. Very well! in that case, the name of Solomon de Caus, I repeat, must disappear from the history of the steam engine, as I have erased from it the Marquis of Worcester; but, unless this new name belongs to some personage born in the British isles, there will be still room for correcting this assertion so often reproduced. "The steam engine has been the invention of a few individuals, all Englishmen."

Many enlightened men of science and mechanics attach small importance to the first idea of the application of steam as a motive power. The ancients, say they, who attributed earthquakes to the instantaneous develop-

\*Notwithstanding this laboured argument, it appears to me, that if the figure given of Porta's machine is correct, it is the true germ of the engine for raising water, afterwards used by Savery; without, however, using the principle of condensation.



ments of steam; the mechanician who proposed to make all the planks of his neighbour's house move backwards and forwards by means of the same agent, knew as much, and have said as much about it, in the main, as Solomon de Caus, or Worcester. If there existed, they add, a useful draining machine in which the immediate action of steam raised a liquid, one might imagine the importance which has been attached to the experiments of these two French and English engineers; one might then, on the score of a first germ, give a moment's attention to the metallic ball of the first and the obscure descriptions of the second; but there is no analogy to be traced between them and the steam engines now in use. The invention of these engines consist entirely then in a cylinder in which a piston moves with an alternate rectilinear motion, and in the means of obtaining this effect. If the first employment of steam in any apparatus as a principle of motion, gives a right to the title of inventor, Hiero of Alexandria deserves the distinction; the rotary engine of this mechanician has been very properly set aside in the contest, because it has neither in shape nor in the manner in which the steam operates any affinity with the engines of our days; those then of Solomon de Caus and Worcester, which have no greater resemblance, should be in like manner set aside. The velocity of water is equally the cause of motion in an undershot water wheel, and of the ascent of the liquid in the hydraulic ram; if it had been concluded from that circumstance, that the inventor of the wheel ought also to be considered the inventor of the ram, every body would have exclaimed against it; and yet, with regard to steam engines this has been the mode of reasoning without its having been perceived. Caus or Worcester, placed to day, with the knowledge of their era, before one of Watts' engines in operation; would neither the one or the other of them even suspect that steam was the cause of motion; and yet they are called the inventors of it!

While citing these reflections, I have given them all their weight. It would be an error to conclude from this, however, that I adopt them without modification. I grant very willingly, that the inventors of the engine with a piston, of the alternate movement, and the contrivances which produce it, ought to be placed in the foreground; this concession made, I cannot admit that the first idea of employing steam as a principle of motion ought not to figure in the history of the steam engine actually in use.

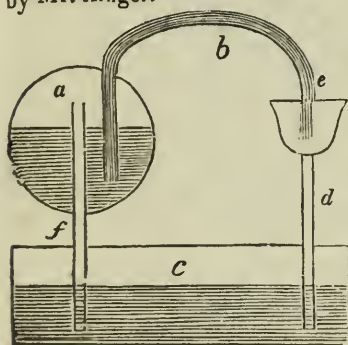
Moreover, it is just to acknowledge, and it is an error from which I have not myself entirely escaped, that it is wrong to consider the steam engine as a simple machine, the inventor of which we must absolutely find. What conclusion could have been drawn, for instance, if this method had been pursued in writing the history of watch making? who is the inventor of a watch? nobody; but it is natural to ask who is the inventor of the various escapements, the compensating balance, &c. &c. In the steam engine, also, there exists many capital ideas which would not have emanated from the same brain. The object of the historian ought to be, to class them in the order of their importance, to give to each inventor that which belongs to him, and to set down exactly the dates of the various publications. In attempting last year to acquit myself of this task, I thus pointed out the characteristic features of the engines now in use.

The idea of a steam engine having a piston operating with an alternate movement.

The production of this alternate motion, by a combination of the elastic force of steam with the property of condensing.

The various, and more or less advantageous ways of effecting this cooling.

No one will dispute that these are the principal features of the engines in use. But I have proved in 1829, that the first two ideas belong to Papin. To admit the truth of my demonstration, would have been to put a stop to the controversy, to confess that the French have been very instrumental in the invention of the steam engine. Great care has therefore been taken not to make this concession. Nevertheless, Papin's publication is indisputably older by many years than those of Savery, Newcomen, and Cawley; the discussion could not be sustained on that ground, and Mr. Ainger, who doubtless perceived it, has chosen an entirely different one: he has decided, cost what it may, that Papin's discovery should be found in some more ancient author, and he has pitched upon Hiero of Alexandria. It is very true, that by this, a new and wide breach is made in the assertion, that: "the steam engine is entirely due to Englishmen;" but the inconvenience is comparatively a small matter as long as it is successful in excluding every French claim. Let us then examine the new claims of Hiero, discovered by Mr. Ainger.



been driven over by the elasticity of the vapor. Thus the water is alternately expelled from, and restored to the globe, by the alternate production and condensation of elastic vapour, (p. 326.)"

"This apparatus, says Mr. Ainger, anticipates the principle of both the contrivances on which M. Arago builds his theory, that the steam engine is a French invention."

This is not all; I read in the 337th page of Mr. Ainger's memoir: the apparatus in which Papin created the alternate motion of a piston by the production and condensation of steam, does nothing more than illustrate "a well known physical fact. That a vacuum was left by condensed steam was known from the time of Hiero at least," and further on in the 338th page, "Papin was not the first by 2000 years, who saw that condensed aqueous vapour left a vacuum." . . . . . "Papin's apparatus does not use both the elastic force and condensation of the steam, and if it had, he was not the first who combined in the same machine the elastic force of the vapour and its condensability, for Hiero's apparatus does the same thing."

I have some difficulty, I confess, in suppressing the expression of the sentiments to which these various paragraphs unavoidably give rise. The reader, however, will supply it, for I shall place in face of all these passages in which such explicit mention is made of *vapour* produced, and *vapour* condensed, a faithful translation of the explanation which Hiero has given of

his apparatus. I say a *faithful* translation, and no one will doubt it when I state that I have applied to Mr. Letronne, that I might have, as it were, a legal, and unexceptionable authority.

"Let ACDB be a closed basis, across which passes a funnel, the pipe of which shall be not far from the bottom (of this basis); let there be (more-over) a globe EF, from which a tube shall descend in the base to a small distance from the bottom of the apparatus. A curved siphon is fitted in such a way as to penetrate into the water in the globe. As soon then as the sun comes to strike this globe, the air which it contains being heated will press the liquid; the latter will escape through the siphon and will descend into the base by the funnel. But when the apparatus is in the shade, the air (less dilated) making room in the globe, the tube will take up the liquid again. This phenomenon will occur as often as the sun strikes the globe." (The words in parenthesis are added to the text for the sake of clearness.)

The reader has now before his eyes the passage, but the unaltered passage, according to which they would deprive Papin of the honour which so lawfully belongs to him, of having been the first to employ steam to make a vacuum under the piston, and to give the crank an alternate motion. I beg him therefore to have the kindness to compare the words of the Greek author with Mr. Ainger's explanation, and he will see that the words *vapor, elastic vapor, condensation of vapor to produce a vacuum*, are pure inventions; that Hiero says nothing about them, that he did not dream of it; that his aim, his only aim is to make use of the elastic power of the AIR contained in the globe EF, although the word *air* does not once occur in the paraphrase of the English author.

Mr. Ainger could not suppose that I would leave his memoir unanswered. How then are we to explain the numerous and important alterations to which he has subjected the words of Hiero of Alexandria?

The question is not certainly one of easy solution; this is, however, the manner in which Mr. Ainger perhaps has reasoned.

Since the apparatus of the Greek mechanician contained water, there was in his globe vapor mixed with air; this vapor must have been more abundant as it became warmer; (we know it now perfectly;) therefore nothing hinders me from affirming that the movement of the liquid was owing to the vapor's being more elastic during the day than in the night. It may be said, perhaps, that the effect arising from this cause, was but a very small part of that occasioned by the expansion of the air; but as soon as the discussion bears only upon quantities, it will terminate in my favor.

The reply is simple, that the question is not whether there was a small quantity of vapor in operation in Hiero's apparatus, but whether this mechanician had suspected it; now Hiero only speaks of air. If we must record, as the discoveries of an experimenter, all the phenomena which his operations realize, the analysis of atmospheric air no longer belongs to Lavoisier, since the first person in whose hands a piece of metal rusted had, without suspecting it, separated oxygen from nitrogen; Black would not be the inventor of the theory of latent heat, because water was never made to boil without the steam's acquiring, inevitably, the great quantity of caloric, which its constitution requires; the discovery of electricity by contact would no longer belong to Volta; but really to him who first placed two metallic substances of different natures one upon the other, &c. &c.

Finally, I am bound to say, Mr. Ainger, led away by his zeal, has even deprived himself of the use of the arguments which I have just opposed. To be convinced of it, it is sufficient to recall this phrase: "It has been



known *since the time of Hiero*," &c.; or, indeed, this other: "the apparatus of Papin only served to illustrate a *well known fact*, as," &c.

In the various quotations which I have been obliged to present him, the reader will certainly have remarked this passage: "*Papin's apparatus does not use both the elastic force and condensation of the steam.*"

After such a phrase, all discussion becomes impossible. What concession, in fact, can one expect from an opponent determined to gainsay evidence? Papin say you did not use the elastic force and condensation of the steam! But why then *did he put water* upon the lower plate of his cylinder? *Why did he make it boil* when he wanted to give the piston an ascending motion? Why did he take away the fire when the moment arrived to make the piston descend under the action of atmospheric pressure?

Mr. Ainger's unqualified (*inqualifiables*) denials are, without doubt, very astonishing; but it ought to be still more surprising, that a memoir destitute to such a degree of all spirit of justice, of all truth, and of all logic, could have been uttered, listened to, received in an institution once dignified so highly by the lessons of Humphrey Davy, and of Thomas Young, in an establishment which even now has the inestimable advantage of numbering among its professors, learned men of the merit of Messrs. Faraday and Millington. But, every thing considered, these powerless efforts of passion, or of national prejudice, are a solemn homage rendered to Papin's inventions. I do not hesitate then again to state the three important propositions which ended the analysis of this engineer's labors in my historical notice. Mr. Ainger will, unintentionally, have contributed an incontestible evidence in their favor.

Papin contrived the first steam engine with a piston;

Papin was the first to observe that aqueous vapor furnished the means of making a vacuum in any space, however great;

Papin was the first who thought of combining, in the same steam engine, the elastic force of steam with its property, which he pointed out, of condensation by cold.

*On the analysis of limestones, especially the Magnesian kind, and a method of completely separating Lime from Magnesia, when both are present in large quantity.* By ROBERT E. ROGERS, M. D., and MARTIN H. BOYE'.

Carbonate of Lime, associated with more or less carbonate of Magnesia, forms the principal ingredient of limestones. In some varieties the latter substance appears only as a trace, while in others, it amounts to nearly 50 per cent. of the mass. When the proportion of the carbonate of Magnesia is very considerable, the rock is termed Magnesian limestone, or Dolomite, the latter name being mostly applied to the crystalline varieties. Variable quantities of other substances, as Silica, Alumina, and the Oxides of Iron, and Manganese, are generally associated to some extent with the above principal constituents.

The Silica is usually either in the free state, in the form of small transparent grains of quartzose sand, sometimes impalpably minute, or in chemical combination with the alumina and iron, (clays, &c.)

The extensive use made of limestones in the arts and agriculture, as mortars, cements, fluxes and manures, renders it a matter of great importance to procure a certain and expeditious process for their analysis, especially as there exists great diversity of opinion respecting the relative efficiency of the several constituents.

We proceed to describe a mode of analysing calcareous carbonates, which

we have found in practice both certain and expeditious, and therefore, preferable, we conceive, to the methods generally in use, which demand extreme care and considerable time to furnish accurate results. The method here proposed, we have adopted with success in an extensive series of analyses performed for the geological survey of the state.

The limestone is first finely powdered, when a given weight, about 30 grains, is digested in chlorohydric acid in the ordinary way, evaporated to dryness, moistened with chlorohydric acid, and redissolved and filtered. The silica and a large part of the other adventitious substances are thus left upon the filter. They are then calcined and weighed, a correction being made for the weight of the ashes of the filter. These steps give the amount of the *insoluble matter*.

The filtered solution, containing besides the lime and magnesia, portions of alumina and oxides of iron and manganese, is neutralized with ammonia, avoiding an excess, and then precipitated with sulphhydrate of ammonium, a small quantity of which will usually suffice. When the precipitate has subsided, it is filtered, the funnel being covered with a glass plate, so as to exclude the atmosphere, and then washed with water containing a few drops of the sulphhydrate of ammonium. The filter with its contents, is then removed, pressed between bibulous paper, dried and calcined. The alumina, and oxides of iron and manganese are thus obtained together. When their quantity is such as to require them to be separately estimated, it can be done in the ordinary way.

In determining the lime and magnesia, a fresh equal portion of the powdered mineral is employed, which is decomposed by a sufficient quantity of dilute sulphuric acid, with the aid of heat. Water is then added so as to fill the vessel up to a given mark, after which alcohol of known strength is introduced in such proportion as to make the whole solution contain 40 to 41 per cent., (estimated by volume) of alcohol. The alcoholic solution of this strength\* precipitates entirely the *sulphate of lime* along with the insoluble matters. When the precipitate is settled, it is filtered under cover of a glass plate, and repeatedly washed with dilute alcohol of the same strength, as that previously employed, until a barytic solution indicates no trace of sulphuric acid. The whole is now calcined, and the weight of the insoluble matters as already ascertained, being deducted, we obtain the amount of *sulphate of lime*, from which we compute that of the *carbonate*.

The filtered solution now contains the sulphate of magnesia, and an inconsiderable portion of the sulphates of alumina, iron and manganese, besides an excess of sulphuric acid. It is to be evaporated until all the alcohol is dispelled, and then precipitated by pure carbonate of potassa with the precautions usually prescribed. The magnesia, alumina and oxides of iron and manganese, thus precipitated, are filtered, washed and calcined. Subtracting from the weight of the whole, that of the three latter previously ascertained, we find the amount of the magnesia, which is to be estimated as carbonate.

The separation of the lime in the form of sulphate from magnesia, by an alcoholic solution, is so complete, as to make it unnecessary to estimate directly the magnesia, except when we desire to check one result by the other. The above process, it need hardly be said, will apply equally to the analysis

\* Alcohol of this strength has a *specific gravity* of 0.951 to 0.949 at 60° Far. and marks between 17° and 18° Baumé. Alcohol of the shops (alcohol rectificatus Lond. Phar.) marking 51½ Pennsylvania proof—has a specific gravity of 0.835. Five volumes of this, and 6 a 6½ volumes of water, will give a very suitable mixture for the above purpose of analysis.

of other substances than limestones, in which lime and magnesia abound, for we have only to precipitate these earths as carbonates, convert them into sulphates, and then treat them with dilute alcohol after the manner described.

We present the following analyses by way of illustration.

1. A white crystalline dolomite, from the neighbourhood of Montville, New Jersey. *Specific gravity*—2.853.

A portion, 1.469 grammes, was raised to a dull red heat, and the water, which was received in a tube containing chloride of calcium, was found to weigh .007 gm. or .48 per cent. This small amount of water is not expelled at the temperature of boiling water.

Two other portions of the powdered mineral, treated after the method described, gave these results :

|                                                      |               |
|------------------------------------------------------|---------------|
| Insoluble matter,                                    | .04 per cent. |
| Alumina, Ox. Iron, and Ox. Manganese,                | .15           |
| Sulphate of Lime, and insol. matter,                 | 76.09         |
| Magnesia, Alumina, and Oxides of Iron and Manganese, | 20.70         |

By subtracting the insoluble matter .04 from the joint weight of the insoluble matter and sulphate of lime 76.09, we get 76.05, and subtracting the alumina and oxides of iron and manganese from the joint weight of these and the magnesia, we have for the magnesia 20.55.

A reference to the annexed table, the use of which will be explained, shews that 76.05 per cent. of Sulphate of lime is equivalent to 31.54 per cent. of lime, or to 56.11 per cent. of carbonate of lime.

It also appears that 20.55 per cent. of magnesia is equivalent to 42.54 of carbonate of magnesia. The result will therefore stand thus ;

|                                           |             |
|-------------------------------------------|-------------|
| Carbonate of Lime,                        | 56.11       |
| Carbonate of Magnesia,                    | 42.54       |
| Alumina and Oxides of Iron and Manganese, | 0.15        |
| Insoluble matter,                         | 0.04        |
| Water,                                    | 0.48        |
|                                           | <hr/> 99.32 |

Were we to estimate the magnesia in this case by the loss, it would be 43.22

Table for calculating Lime and Carbonate of Lime from the Sulphate of or its Sulphate.\*

|                      |                       | 1       | 2       |
|----------------------|-----------------------|---------|---------|
| Sulphate of Lime     | Lime                  | 0.41532 | 0.83064 |
| Sulphate of Lime     | Carbonate of Lime     | 0.73780 | 1.47561 |
| Magnesia             | Carbonate of Magnesia | 2.07002 | 4.14004 |
| Sulphate of Magnesia | Magnesia              | 0.34015 | 0.68030 |

The first vertical column of the table contains the names of the substances, from a known weight of which we wish to compute the weight of the substances embraced in the second column. The figures in the horizontal lines represent the quantities of the substances named in the second verti-

\* This table is taken partly from H. Rose's Analytical Chemistry, vol. ii, and partly calculated for the present purpose. The principle of this method of calculating analytical results was first set forth by Poggendorf, in his Annals, vol. xxi, and has since been extensively carried out by H. Rose in his work just mentioned.



carbonate of magn. equivalent to 20.88 magnesia, or, 0.33 per cent. more than the amount found by direct estimation.

With a view further to shew that the *whole* of the lime is procured by the above method, and therefore, that we may safely estimate the magnesia by subtracting the carbonate of lime and other ingredients directly got from the weight of the mass, we subjoin the following example of a specimen found to contain no magnesia.

2. A white crystalline, imperfectly saccharoidal limestone, from near the mouth of Yellow Breeches Creek, Susquehanna River, Pa.

From one portion of the powdered mineral, treated with chlorohydric acid we obtained

|                            |               |
|----------------------------|---------------|
| Insoluble matter,          | 2.3 per cent. |
| Alumina,                   | 1.2 “         |
| Ox. of Iron and Manganese, | none          |

Another portion treated with sulphuric acid and diluted alcohol of the proper strength, gave

|                                   |        |
|-----------------------------------|--------|
| Insoluble matter and Sulph. Lime, | 133.19 |
|-----------------------------------|--------|

Subtracting the insoluble matter, 2.3, from the sulphate of lime and insoluble matter, we have sulphate of lime 130.89 per cent., which is equivalent, as the table will show, to 96.3 per cent. of carbonate of lime.

The amount of water as derived from a third portion was 0.2 per cent. Our analysis therefore stands thus :

Composition in 100 parts—

|                        |      |
|------------------------|------|
| Carbonate of Lime,     | 96.3 |
| Carbonate of Magnesia, | none |
| Alumina,               | 1.2  |
| Insoluble matter,      | 2.3  |
| Water,                 | 0.2  |

100.0

Lime, and also for calculating the Carbonate of Magnesia from Magnesia

| 3       | 4       | 5        | 6        | 7        | 8        | 9        |
|---------|---------|----------|----------|----------|----------|----------|
| 1.24596 | 1.66128 | 2.07660  | 2.49102  | 2.90724  | 3.32256  | 3.73788  |
| 2.21341 | 2.95121 | 3.68902  | 4.42682  | 5.16462  | 5.90242  | 6.64023  |
| 6.21006 | 8.28009 | 10.35011 | 12.42013 | 14.49015 | 16.56017 | 18.63019 |
| 1.02045 | 1.36060 | 1.70075  | 2.04009  | 2.38105  | 2.72120  | 3.06135  |

cal column corresponding to those quantities of the substances in the first column, which are signified by the numbers at the head of each vertical division of the table. An example will render the mode of using the table sufficiently plain.

In the first analysis, the amount of sulphate of lime was 76.05. To ascertain from the table the quantity of carbonate of lime equivalent to this amount of sulphate, we find on the horizontal line appropriated to the carbonate, the quantity due to seven parts of the sulphate—namely 5.16463, then the quantity due to six parts, namely 4.42682, and then that equivalent

to five parts or 3.68902. By arranging these in their proper decimal order, so as to impart to the several amounts taken from the table, the value they are intended to have as units, tenths, hundredths, &c., and then performing a simple addition, we get the amount of carbonate corresponding to the whole quantity of the sulphate.

The figures will stand thus:—

|                   |            |
|-------------------|------------|
| Sulphate of Lime  | 76.05      |
|                   | <hr/>      |
|                   | 51.6462    |
|                   | 4.42682    |
|                   | .000000    |
|                   | 368902     |
|                   | <hr/>      |
| Carbonate of Lime | 56.1099102 |

In the same manner, 20.55 of magnesia will be found to be equivalent to 42.54 of carbonate of magnesia—thus:—

|                       |        |
|-----------------------|--------|
| Magnesia              | 20.55  |
|                       | <hr/>  |
|                       | 41.400 |
|                       | 00.000 |
|                       | 1.035  |
|                       | .103   |
|                       | <hr/>  |
| Carbonate of Magnesia | 42.538 |

As it may be sometimes convenient to evaporate the magnesian solution to dryness; ignite it, and from the sulphate of magnesia thus procured, compute the magnesia or its carbonate, we have introduced into the table a column to facilitate the calculations.

### Physical Science.

#### *Examination of the Meteorological Theories of Mr. Espy and Mr. Redfield. By a Correspondent.*

There are none of the operations of nature, with which we are in more immediate or sensible contact, or in which all are more intimately concerned,—and yet none, probably, which have been less studied or comprehended, or the facts and principles of which have assumed less of the form of a regular science, than those relating to the *weather*,—or Meteorology. It is true there have been various hypotheses and theories started, with a view to account for the various states and changes that are observed to occur in our atmosphere. And one theory, the Huttonian, from its superior plausibility, and for the want of a better, has become generally current.

That the Huttonian theory of storms is free from difficulties and objections, no one who has studied the subject closely, will pretend. The phenomenon to which it applies with the least objection, and the only one in fact, in relation to which it has even the appearance of plausibility, is that of *rain*. But even here, it is at fault. It has been demonstrated, (as I think) to be entirely insufficient to account for the *quantity* of rain, which is often observed to fall in a given time. It is no very difficult problem to ascertain the quantities of hot and of cold air of given temperatures, and under given and known states of the atmosphere, that would be required to

be mixed, to deposite a given quantity, say an inch of rain. And it is somewhat surprising that the solution of so important and natural a question, should not have been demanded by scientific men, as a preliminary condition of receiving the theory. The most favorable circumstances supposable, as to the quantities of cold and hot air, the extremes of temperature, the quantity of vapor in solution, &c., would, upon this principle, be insufficient to produce a single inch of rain; even allowing, what is scarcely supposable, that large masses of warm and cold air in the same neighborhood, would of necessity, become thoroughly mixed.

Of late, the subject of meteorology has received far more attention than formerly, both in this country and in Europe. Enquiries and observations of a scientific and comprehensive character have been instituted, which give promise of most important results. There are, in this country, two gentlemen in particular, whose labors in this department of science, have become quite conspicuous; one of whom, has promulgated a new and bold theory, which is creating no little sensation. I, of course, allude to Mr. ESPY, and Mr. REDFIELD. The object of the present paper is to examine briefly, some of the views of these two gentlemen.

Unfortunately, or it may be fortunately, for the cause of science, these two meteorologists have arrayed themselves against each other. Or, rather, Mr. Redfield has assailed with great vehemence the new theory of Mr. Espy; while the latter has, with much zeal, and not less ability, exerted himself to defend and fortify, and extend his peculiar views. Mr. Espy has taken very little pains to controvert any of Mr. Redfield's doctrines, unless it be that of the *whirlwind* character of storms; which the latter supposes he has fully established, and which he appears to consider fatal to Mr. Espy's theory. I am not aware that Mr. Redfield has, as yet, advanced, or advocated any particular theory, as to the cause of storms; though in one of his papers, he intimated that he had constructed, or was constructing a theory, which would be made public in due time.

Mr. Espy's theory is briefly this: He supposes that the air at the surface of the earth becoming rarified, ascends: and carrying up with it a certain amount of vapor which it holds in solution, it rises, (supposing the circumstances to be sufficiently favorable) until by diminished pressure, and consequent expansion, it is cooled down, so that it can no longer retain all its vapor, but deposite a portion of it in the form of cloud; that the latent heat disengaged by condensation, acting upon the air with which it is in contact, greatly increases the upward tendency of the air, and the further condensation of vapor, until it falls to the ground in the form of rain; and that in consequence of this upward current, or vortex at the centre, the air rushes inwards from the outer parts of the storm, to supply the vacuum.

This theory then requires that the wind should blow at the same moment from all the exterior parts of a storm, or perhaps from parts beyond its borders *inwards*, towards the centre. Is this the fact? Mr. Espy alleges that it is; and he has collected a great number of observations from different parts of the country, relating to certain storms, which seem to justify that conclusion, and, so far as they can be relied on, to establish his theory. If this one single fact, an inward motion of the air in the borders of storms, should be established, I cannot see why it would not be conclusive, or nearly so, in favor of Mr. Espy's theory. He maintains, however, that there are many other facts which support it, while there appear to be none that contradict, or are inconsistent with it. He further maintains, not only that all known facts support his theory, but that his theory explains and accounts



for all known facts. He holds that the same laws, as to the disengagement of latent heat, condensation, &c., are in operation, whether in the production of rain, snow, or hail, or in the tornado or the water-spout.

This theory, like every other new doctrine, whether true or false, meets with opposition; some in the shape of argument, but much more in the form of ridicule. Even Mr. Redfield, it must be admitted, has resorted in no small measure to this latter mode of attack. Perhaps he considers it too preposterous to deserve a serious refutation. Certain it is, that with all his apparent anxiety to demolish it, he has taken very little notice of the principles and argument on which it is built. For aught he has said, one might doubt whether he has taken pains to ascertain what the theory is, except in its relation to a single fact, the inward tendency of the air. Of this, I shall have occasion to speak in another place. The same remark applies substantially to nearly all the opposition that has appeared. The real merits of the theory, the principles and reasoning of which it is composed, have scarcely been touched. Indeed, the principles, as such, aside from their applicability to the case in question, probably will never be disputed. They are as well established as any laws in physical science. The theory involves very little, if any thing, that is purely hypothetical; unless it is the *combination* of certain principles.

It may be worth while to state in the form of separate propositions, the leading principles or facts which the theory embraces. Mr. Espy assumes, among other things, as parts of his theory—

That when a portion of air at the surface of the earth, becomes more rarified than the surrounding air, it ascends:

That the atmosphere is capable of containing, and does always contain, a certain quantity of water:

That this capacity of the atmosphere for containing water increases rapidly with the temperature:

That the quantity of water actually in solution, varies greatly at different times and places, independently of the temperature; the air at a given temperature, sometimes being filled nearly or quite to the extent of its capacity, while at others it falls far short of it:

That if from any cause, the temperature of a portion of air, containing a given quantity of vapor, be reduced to a certain point, that is, until the capacity be brought below the dew point, it must deposite a portion of the water:

That expansion arising from diminished pressure, is attended by diminished temperature; that the actual diminution of temperature, on this account, in ascending from the surface of the earth, is about one degree for every hundred yards; and that consequently, air, highly charged with vapor, that is, with a high dew-point, would not have to ascend very far before condensation must commence:

That the condensation of vapor is attended with the disengagement of a very large quantity, more than a thousand degrees of latent heat; in other words, sufficient heat is set at liberty by the condensation of a given quantity of vapor, to raise the temperature of a hundred times that quantity of water ten degrees.

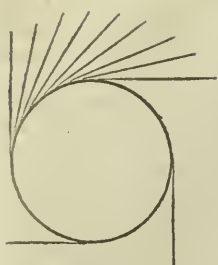
These propositions need no proof. The truth of all of them has been demonstrated a thousand times; and is, I take it, universally admitted. So far then, as they appear to apply to the theory in question, they afford evidence in its favour. But it is not enough that the theory embraces several known truths. It is important to enquire whether they have any obvious

and necessary connexions with each other, and a probable connexion with the phenomena which the theory professes to explain;—whether the action of one principle should, or might, prepare the way for, and bring into play, another, and so on:—Whether it is possible, and if so, whether it is probable that the several principles and conditions should conspire to produce the effect supposed.—Affirmative answers to such enquiries, would afford additional evidence in favour of the theory. How is it in the case before us? Is it probable that the air at a particular place would become so much more rarified than the surrounding air, as to cause it to ascend several hundred yards; and at the same time, that the dew point be so high that before the ascending air should come to an equilibrium its temperature should have sunk to that of the dew point, so that condensation and the formation of cloud should commence? in other words, that the air should ascend as many hundred yards as there are degrees between the dew point and the original temperature? Then is it probable that the heat disengaged by this partial condensation, would be sufficient to continue and increase this upward tendency? that the vacuum thus caused would continue to be supplied by air with a high dew point from below? that the ascending mass would continue to rise until the temperature be so much reduced by diminished pressure, notwithstanding the counteracting influence of the disengaged heat, as to cause a further condensation so copious as to produce rain? To me this does appear sufficiently probable. At least I can discover nothing in it improbable, much less impossible or absurd.

But after all, the question must be settled by *facts*. And to these Mr. Espy appeals with confidence. The great and fundamental fact which alone, if established, must be decisive, is the inward tendency of the air, in the borders of storms. It is this fact which is chiefly regarded in the controversy with Mr. Redfield. To notice, briefly, this controversy was a leading purpose of the present essay.

Mr. Espy maintains that the air in the borders of storms generally moves inwards; and that this inward motion is the *effect* of an upward current at the centre. Mr. Redfield contends that the motion of the air in the borders of storms is gyrotory, or of a whirlwind character: and instead of being the effect is the *cause* of the upward current, if, indeed, such currents exist. What is the cause of this circular motion of the air, he has not attempted to show.

Now that the fact is as Mr. Redfield supposes, I am not at present disposed to deny. It appears to me that Mr. Espy has sufficiently proved that the wind does blow *inward*, to some extent at least; but that it should, before it reaches the centre, assume a gyrotory motion, as *water*, in a vessel, flowing through an orifice in the centre of the bottom, is known to do, is, I think, more than probable. That this should take place somewhat remote from the centre, and even influence, materially, the direction of the wind, in the very borders of the storm, I think is not improbable. But what then? Suppose the whirlwind motion be admitted to the full extent of Mr. Redfield's views,—does it follow that the tendency is not inward? By no means. The air moves inwards, according to Mr. Redfield, just as truly, though not so directly, as it does according to Mr. Espy. A glance at the accompanying diagram will make this apparent without a word of explanation.



Indeed, Mr. Redfield himself has admitted, more than once, that there is an “involved spiral course of the wind, inwards.”\* And what is there in a *spiral*, or in direct movement inwards, which contradicts, or is inconsistent with the theory of an upward vortex? I can discover nothing. On the other hand, *rejecting* the doctrine of an upward vortex, Mr. Redfield’s theory, I apprehend, is chargeable with the very absurdity which he has imputed to Mr. Espy’s (but which does not belong to it,) the excessive accumulation of air at the centre of the storm. Without admitting an upward current, operating as the *generating cause*,—not as a *consequence* of the inward motion,

there *is* an absurdity in supposing any inward motion whatever, either direct or spiral;—an absurdity, not merely of supposing a central accumulation, contrary to fact, but of supposing the air to move inwards and accumulate from all quarters, *without a cause*, and contrary to known laws. Setting aside the upward central vortex, (which, if admitted, is sufficient not only to prevent any accumulation from the inward motion of the air, but to account for that motion) what possible cause can be assigned for either centripetal or circular motion? If the air moves either directly or spirally towards a particular point, or if it revolves around a given point, there must be some cause for it. Some force must act upon it, either from within or without. Mr. Redfield does not need to be told that the air, as well as all other matter, will always move in straight lines (if it moves at all,) unless it is acted upon by some force, foreign to itself. Circular motion is a *forced* motion; and is always produced in one of two ways. Either the moving body is resisted by some external barrier, as a wall, or it is retained in its orbit by some centripetal force, as a cord, or the attraction of gravitation. It is either *pushed* or *pulled* out of a straight line, into a circle. How does this apply to the case in hand? The air in the borders of a storm certainly cannot be attracted or held by any force at the centre. And, supposing the density to be the same within and without, (which ought to be, if there is no upward tendency, to remove any part of the pressure,) then the outer air could not act as a barrier to resist the centrifugal tendency of the revolving mass within, supposing it possible for a revolving motion to be given to it, so that admitting the “whirlwind” to exist, the tendency must be outwards, instead of inwards.\* But what should give the air, in a storm, a whirlwind motion, if it is not the force of the atmospheric pressure without, driving it towards a vortex within? It is easy to conceive of a whirlwind being produced by the rushing of the air from all directions to fill a void occasioned by the withdrawal of a portion at a particular place. But to suppose a mass of air to commence moving in a circle, while there is no tendency to a central vortex, is just as absurd, I apprehend, as to suppose a ball, placed on a horizontal table, to commence moving in a circle.

It will not do to reply to this by alleging the known fact of a diminished pressure at the centre of storms, as indicated by the barometer, to account for the whirlwind; for this would be virtually admitting Mr. Espy’s theory.

\* Mr. Redfield has once or twice spoken of the depression of the barometer at the centre of storms, as if it was caused by the centrifugal effect of the whirlwind, thus seeming to suppose an *outward* instead of an *inward* motion. This idea is certainly inconsistent with what he says elsewhere of a “spiral course inwards,” and of the whirlwind causing an *upward* motion at the centre.



It is very true, that from some cause or other, there is a partial vacuum at the centre of storms; which would, naturally enough, account for the inward rush. This barometrical indication is another *fact* which Mr. Espy urges in support of his theory. It is unnecessary to dwell upon it.

There is then, as admitted on all hands, an inward movement of the air; and yet, so far from any *accumulation*, the quantity at the centre is absolutely diminished. The air evidently escapes *somewhere*, and that without being *pushed* away by what comes in from without, as the state of the barometer plainly indicates. Are there any *facts* to prove that this air goes upwards? In ordinary storms, there is, probably, no positive evidence of an upward current, except what is furnished by the facts just stated. And they alone appear to me to be conclusive. But in tornadoes and water-spouts, the evidence of an upward current of great violence is direct and positive. In severe tornadoes it is not unusual for heavy bodies to be raised suddenly and almost perpendicular, hundreds of feet from the surface of the earth; and in water-spouts it is well known that the water is carried up with great violence and in immense quantities, from the surface of the ocean. It is unnecessary to remark that these facts prove the existence of an upward current of immense velocity and force.

On the whole, in view of the facts, and the known laws of heat and condensation, already quoted, I cannot resist the belief that Mr. Espy has discovered and developed the true law of storms. He may be wrong in some of his views; but his theory, as a whole, is supported, if I mistake not, by principles and arguments, not likely to be disproved. If it should bear the test of future observation and scrutiny, the discovery will form an epoch in the annals of science. In the mean time, it is much to be hoped, and there is reason to expect, that its merits will be thoroughly canvassed, both by its advocates and opponents. The opposition which it encounters is, by no means to be regretted, so far as it is conducted with fairness and candor. If the doctrine is true, opposition, instead of overthrowing, will only help to establish it. If it is fallacious, the sooner the fallacy is exposed the better.

L. H. P.

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## Civil Engineering.

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*A Popular Exposition of the Incorrectness of the Tariffs of Toll in use on the Public Improvements of the United States.* By CHARLES ELLET, Jr., Civil Engineer.

The object of this essay is to point out, in a brief and popular view, the consequences of some of the errors which are committed in the charges assessed on the public works of this country.

The writer has recently published a work\* in which he has attempted to expose the true principles of trade, and to show the only correct mode of determining the tolls proper to be levied on our great lines of Canals and Railroads. But it has been suggested to him by some intelligent readers of that work, that the method of analysing the subject which he has been compelled to adopt in it, is not the best adapted to the pursuits of the class of readers most likely to be interested in the subject; and that some advantage might be derived from exhibiting, in a popular form, a few of the results

\* "An Essay on the Laws of Trade in reference to the works of Public Improvement in the United States."

which were there obtained by a different process. This essay is intended to subserve that purpose; and to show that the principles on which all the tariffs in the country are based, are unsound, and lead, in their application, to oppressive injustice to a portion of the community, and to great loss of trade and revenue to the improvements.

§ 1. *Of the Importance of the Subject.*

1. There are no questions of public policy which are thought to concern so intimately the general and particular interests of the people of this country, as those which relate to their internal improvements. The consideration of this subject constitutes the greatest part of the legislation of nearly all the States in the Union, and the employment of the privileges sanctioned by the law, constitutes a prominent portion of the efforts of individual enterprise. There are now completed and in use in the country more than three thousand miles of railroads, and not less than three thousand miles of canals, the construction of which has occasioned an actual expenditure of probably \$150,000,000, and for which loans have been incurred by the State governments or incorporated companies, to nearly an equal amount.

This enormous investment of capital is by some viewed as alarming; and might, indeed, appear so, when it is considered that a draft of some eight millions of dollars will be annually made on the country for the payment of the interest on this sum, and that the principal itself, in the brief space of twenty years, may possibly have to be refunded. On the other hand, there are sanguine advocates of improvements, who look to the revenue to be derived from the works themselves, consequent on the rapid growth and progressively increasing productiveness of the country, as offering an ample guaranty for the prompt payment of the interest, and the due liquidation of the principal, of the debt.

It is not the intention now to discuss this momentous question, or to endeavour to ascertain which of these hypotheses approaches nearest the truth. Both are but surmises, advanced as the result of a hasty glance at the facts, or possibly based on no safer evidence than the prepossessions, or mere conjectures, of the parties. They are wanting in that detail, that exhibition of statistical information, without which it is impossible to generalize with security.

Doubtless many of the works of the country will possess abundant means to sustain their credit; and among so many enterprises, it is equally probable that some have been undertaken which will fall very far short of the expectations of their patrons.

2. But, whatever may be the general ability of these immense lines of improvements, it is certain that the success and profitableness of those which are now progressing under the fairest auspices, are not so well established but that it ought to be an object of deep solicitude with their proprietors to find the means of increasing their productiveness. To every State that has embarked in a career of internal improvement, and to every individual who has invested his property in such stock, it is an interesting question to ascertain the most efficient means of equalizing the charges on the trade, and increasing the revenue and tonnage of the line.

The public improvements of Pennsylvania are sinking that commonwealth in debt about *a million and a half per annum*—or, in other words, the interest on the loans incurred for their construction, added to the annual charges for repairs and superintendence, exceeds the gross revenue of the works from one to two millions of dollars per annum.

Those of Ohio, and many of those constructed by great incorporated joint stock companies, exhibit balances scarcely less unsatisfactory: and, although these unpropitious results cannot be fairly adduced as evidences of the impolicy of the undertakings, they are facts which may be legitimately used in evidence of the necessity of inquiring into the correctness of the principles of their management. Many of them are now regarded as partial failures, and have involved the community in great pecuniary difficulty. Possibly a careful investigation of the principles on which their tariffs have been established, may lead to the conviction that there is some radical error of administration which may be advantageously corrected.

No more fitting season can be selected for such an investigation than the present. The system of public improvement is now prostrated throughout the country for want of the means necessary for the extension of the works. Those who have been engaged in their execution, may therefore take time to consider by what mode the tax with which they load their constructors may be lightened, or the revenue they pay may be augmented.

3. It is not less important that the charges adopted on the works should be those which would render them most productive to the stockholders, or to the commonwealth as a proprietor, than that they should be reconcilable with principles of justice. In levying a tax for purposes of revenue on any portion of the property of the public, it has been an object of legislation in all times, to make the nearest possible approach to equity in its distribution. The tolls charged on the works of the commonwealth are intended for revenue, and they should be so adjusted, if such an adjustment be practicable, as to produce the greatest possible revenue with the least inequality in the taxation.

At the same time it is essential to have due regard to the cultivation of the trade, which is the primary object of the improvements—a condition which must be reconciled with those above stated—of drawing the greatest possible revenue from the transportation of the produce of the country, and an adherence to principles of equity in the distribution of the tax.

This may appear to be a complicated problem, the solution of which, however desirable in itself, can scarcely be regarded as attainable in practice.

I shall endeavour, however, to show by a few evident propositions, both that the principles by which these charges are now assessed on all our great lines, are such as operate unjustly upon a large portion of the country; are such as in great measure defeat this primary object of the improvement,—that of inviting the distant trade to a market—and such as reduce the revenue far below the limit belonging to a more just and more judicious tariff; and, at the same time, that an attention to the true laws of trade will render the avoidance of these errors exceedingly easy.

*2. Of the Incorrectness of the Principles on which Tolls are at present assessed.*

4. To be able to appreciate the necessity of a departure from the principles on which the present charges for the use of our public works are established, it is essential to examine into the effective operation of the scale now in use. To render the view which I design to take as little complicated as possible, it may be confined for the present to one of the principal divisions of the trade of the country. For, in treating of the laws of trade, it is found convenient to divide the commerce of the line into two principal classes; in the first of which is included all those commodities which will bear but a



limited charge for their transportation, and which, if taxed beyond that limit, will be excluded from the line and from market. This division usually consists of stone, coal, lumber, ore, lime, and many agricultural productions. Indeed it embraces all articles which will seek a market along the line in question, and no other; and in this respect is to be distinguished from that division of the trade which consists of more valuable commodities, and which, if not accommodated on one line, will find a passage by the route of a rival work.

Our present investigation will be confined to the first of these divisions.

5. The charges which are levied on this trade consist of what are usually termed *freight* and *toll*. If the work be a canal, by freight is understood the charge of the carrier, and by toll that of the state or corporation owning the work. In the management of railroads, it is usual for the company to act as carrier on their own line; and to make but one charge, which is called *toll*, for both objects. In this essay I shall make a somewhat different application of these terms, and designate by *freight*, in either case, every expense actually incurred in the carriage of the commodity, and by *toll*, the clear profit on its transportation. So that if the carrier, or transporting company, charge seven mills per mile for the carriage of one ton of any article, and the cost of repairs and superintendence of the line due to the passage of that ton is three mills per mile, I call the *freight* on the article one cent per ton per mile; and any charge, exceeding this three mills, which is assessed by the state or company, is what I denominate their *toll*.

6. In nearly every tariff of toll adopted in this country, the charge on every article is proportional to the distance it is transported on the line. The *toll* is some fixed amount per ton per mile. This scale of taxation, I contend, is improper and unjust.

To examine the question, let us suppose the article to be lumber, of which the market value, at the point to which it is sent, is \$10 per ton. Let us also assume that the cost of producing this article, or preparing it for shipping on the canal, is \$6 per ton. It is then most obvious that if the charge for transportation on this commodity exceed \$4 per ton it will be wholly excluded from the line; for then the cost of carriage added to the cost of production would exceed the market value of the article, and there could be no profit to remunerate the producer. But if the charge be less than \$4 there will be a certain profit, and the article will be found to seek the market.

If now, this lumber is carried a space of *one hundred miles* to its mart, and the charge for *freight* is one cent per ton per mile, the freight for that distance will obviously be \$1, and there will remain a balance of \$3 for the extreme limit which the article will bear to be charged for toll. The toll levied by the state, at one cent per ton per mile, will be \$1, or one-third the amount, which the article could in this case sustain.

Let us next suppose that similar lumber comes upon the line at a distance of *three hundred miles* from the same mart. The charge for *freight* would now be \$3, and there would consequently be a residue of only \$1 on which the state might levy for toll. The commodity could bear no more than \$1—since that sum added to the \$3 freight would be \$4, or the difference between the cost of producing the lumber and its price in market. But, by the principle of taxation usually adopted, the toll assessed at one cent per ton per mile, would here be \$3, or three times as much as the article would bear. In other words, *at the distance of one hundred miles from the mart, in the usual tariffs, a commodity is charged one dollar where it might bear a*

*charge of three, and at three hundred miles it is charged three dollars where it could bear but one.*

7. Does it need any argument to prove that a scale producing such results is neither compatible with principles of equity or good economy? Is it not manifestly unjust to charge the man who is situated three hundred miles from market three times as much as he can afford to pay, while the man at one hundred miles can afford to pay three times as much as he is charged? Is it not any thing but good economy to tax all the trade in this article beyond two hundred miles so heavily that it is totally driven from the line, when, if the tolls were differently assessed, it might be invited, and made to pay a respectable revenue to the state? And is not the primary object of the work defeated by the adoption of a tariff that excludes those commodities from it which it was especially intended to draw to market—an effect which is accompanied by a direct sacrifice of trade, revenue, and even justice?

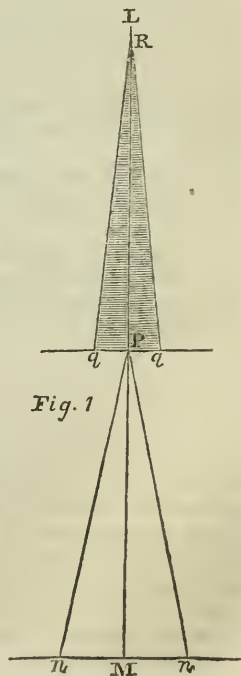
8. I think it can scarcely need more than this plain exposition to make clear to any reflecting mind that some of the charges on the public works of this country need revision: that they are based on principles which are unsound, and at once do injury to the proprietors of the work, and injustice to a large portion of the public. The commonwealth, as the constructor and owner of the improvement, is a sufferer in the loss of the trade that is excluded, and the revenue that might be derived from it; the citizens of the emporium which is the mart of the line, suffer from the contraction of their business in consequence of the exclusion of the articles in which they traffic; and the country traversed by the improvement, and taxed, perhaps, for its construction, suffers from its inability to share the benefits which the work was designed to confer.

§ 3. *Further evidence of the loss of Trade consequent on uniform Charges.*

9. To render more palpable the fact that a charge for toll proportioned directly to the distance will cause the exclusion of a certain amount of tonnage, without conferring any compensating advantage, we will consider the subject with the aid of a diagram. (See Fig. 1.)

Let M in the figure be the position of the mart, and ML the line of the improvement: and let us assume, as before, that the commodity will be capable of sustaining a charge of \$4 per ton for its transportation; that the toll is one cent per ton per mile, the freight likewise one cent, and the cost of carriage on the lateral roads by which the tonnage is brought to the work, is ten cents per ton per mile.

The distance M n from which this commodity can be brought to the mart at M on the lateral roads n M, n M, will then be forty miles; and the distance M P which we can afford to carry it along the improvement, at an aggregate charge of two cents per ton per mile, will of course be two hundred miles. The area of country, therefore, which will supply trade to the line, will be represented by the triangle n P n, having a base n n of eighty miles, and a height M P of two hundred miles.



10. Now, it is apparent that the line will receive no tonnage of this article, from beyond the point P; and therefore, that if the trade were permitted to come free of toll from beyond that point, there would result a certain increase of tonnage, which would be accompanied by no diminution of revenue.

Under such an arrangement of the tariff, the charge for freight from P to M, for produce coming from the country beyond P, would be only \$2, and there would consequently be left a balance at P of \$2 out of the limit of \$4 which the article could sustain, to bear the cost of its carriage along the lateral roads to the improvement, and down the improvement to the mart.

This balance will be sufficient to pay the cost of transportation on the lateral road from *q* to P, a distance of twenty miles, at ten cents per ton per mile; and the charge for freight along the improvement, from R to P, a distance of two hundred miles, at one cent per ton per mile. It would, therefore, be within the ability of the state or company, in this example, to extend the benefits of the improvement four hundred miles into the interior, instead of two hundred, and increase the tonnage of the line, with all the incidental advantages, *fifty per cent.*, without sustaining any loss of revenue.

11. It is far from my intention here to advocate a tariff arranged with a view to this effect; but merely to show what is lost by those which are commonly adopted. Instead of draining only the country contained in the triangle *n P n*, which will supply the trade where the charge for toll is one cent, and freight one cent, by charging toll from M to P, and permitting all articles brought from beyond the angle P to pass free of toll, the shaded triangle *q R q* in the figure, will be added to the area using the work and supplying its tonnage. The value of the improvement to the country will be increased one half; the trade of the city at M will likewise be increased one half, and the value of the property of the commonwealth, as far as it is dependent on the activity of the work, will be proportionally augmented.

But such an arrangement would effect injustice, and could not therefore receive the sanction of a government administered in a due regard to the first principles of its existence—the equal protection of the citizens, and an equitable distribution of the benefits which its constitution was intended to confer.

Such a tariff would augment the tonnage of the line—but it would produce that result by taxing the citizen immediately at P \$4, and excluding him from the work; and the neighbour immediately beyond P but \$2, and inviting him at the expense of a premium.

Besides these objections to this arrangement, there exists the additional and important one, that it would not fulfil another imperative condition—that of obtaining the greatest revenue from the trade.

TO BE CONTINUED.

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FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*On the Prevention of Accidents, by Fire, on Board of Steamboats.*

By ITHAMAR A. BEARD, *Civil Engineer.*

Much has been written and published on the prevention of accidents on board of steamboats by the bursting of boilers or the collapsing of flues; and I fear much more will be required to prevent all accidents and fatal catastrophes in boats, which, in too many instances I believe, to arise from a want of due caution on the part of those whose business it is to guard the lives and property of the public, confided to their skill and watchful care.

Besides the ordinary class of accidents, there is another class of which



we have on record several accounts within a few years, and one very recently, of a still more awful and distressing nature. I have reference to the burning of a boat at sea, where the passengers and crew have no alternative, but must either burn or drown.

I do not now recollect having read any efficient mode proposed for extinguishing fire on board a boat, nor any other theory recommended than the ordinary mode with buckets and a fire engine.

Believing that there is always ready at hand and available, with proper fixtures, in every steamboat, an agent much more efficient than water and an ordinary engine to extinguish fire, I deem it a duty to make the suggestion, that others who may be disposed, and have better means than I can command, may try experiments upon it, and test the utility of the theory.

From the few imperfect experiments my means have permitted, I am of opinion, that steam is far preferable to water to extinguish fire. For steam can be made to enter every apartment, birth, and crevice, even where water would not possibly be thrown, and being lighter than air it keeps the space filled instead of falling to the bottom as water would do, and can be as effective on the under side of a ceiling, deck, or floor as it would be on the top, and even more so.

The first that I ever noticed of the effect of steam upon flame was several years since, by carrying a lighted lamp into a room in a dye-house that was filled with steam, and the light was instantly extinguished.

Again, when the steam was issuing from the nose of a teakettle, I have taken a bright coal of fire and held it in the steam, and the fire was quenched in as short a time as if it had been immersed in water, and as effectually through the coal.

Now if the theory be true (which, I confess, needs further experiment and stronger proof) a comparatively trifling expense may furnish every steamboat with certain and available means of readily extinguishing a fire, if it should take in the woodwork of the boat, or in the freight, either on or under deck.

I would propose the following mode of operation. Let a pipe, say a gas pipe, or any other that shall be of strength sufficient to bear the pressure of the steam, be connected with the boiler, either directly or indirectly, at pleasure, and be carried to every apartment in the boat. And in as many places as may be thought expedient, insert stopcocks of such construction that they can be readily and easily opened at any time and by any person.

In case of a fire in any apartment the occupants would of course leave the apartment as soon as possible, and when the apartment should be vacated, let the stopcocks be opened, and force in as much steam as would be practicable. Under deck, and in a close apartment, it would have a double advantage over water, for it would, in a great measure, exclude the air from feeding the flame, at the same time it produced an effect by its moisture, but the greatest effect would undoubtedly be produced by the excluding of the air.

In addition to the foregoing, I would attach pipes and carry them on each side of the engine, fore and aft, upon the deck some thirty or forty feet, and at the terminations I would affix "gooseneck joints," and to these attach several lengths of pipe in joints of six or eight feet, and then another "gooseneck" and to this attach a directing and discharging pipe of about the same length as the other joints, all the connexions to be made with screw joints, or couplings.

The two goosenecks would enable the man having charge of the pipe to convey and use the steam on any part of the deck, with nearly as great facility as water would be conveyed and used with a hose: and, if necessary, any number of goosenecks may be used.

To enable the men to handle and use the pipes without burning their hands, let some two or three feet of each joint of pipe be incased in, or near, the middle, with a tin or sheet brass cylinder (brass is preferable,) one inch, more or less, at pleasure, greater than the steam pipes, and fill the space between the two pipes with pulverized charcoal, pipe clay, or soap-stone dust, and outside of the exterior cylinder wind on some two or three thicknesses of woolen cloth, and this will fully protect the hands of the men in moving and directing the pipes.

It is thought that this mode of extinguishing a fire in a boat may be more effective than a fire engine, and may always be available at the moment it may be needed, whereas, with a fire engine, there must always be a delay, and frequently, perhaps generally, much difficulty in supplying it with water and in getting it into action, and more difficulty, in the terror and confusion in getting hands to work it; and these unavoidable difficulties, it is presumed, would, in most instances, let the fire get such headway that no power on earth could arrest its progress; and inevitable destruction is the consequence.

In any situation, a single bucket of water when a fire first takes, is of more effect than an ocean after the building is enveloped in flames. And on board a boat, especially, it is necessary to stop the progress of a fire immediately and with the least possible delay, for if the wind did not blow, the motion of the boat would produce a current of air sufficient to kindle a fire rapidly.

In general it would be favourable, in case of a fire, to run the boat directly before the wind, and this would, in a measure, neutralize its effect; but circumstances might alter the case in this respect.

As too much precaution, to preserve and render life and property safe, cannot be used, whether philanthropic motives, or those arising from self interest on the part of steamboat owners, be consulted, every boat should be well and constantly furnished with every possible means of safety or escape in case of accidents of any kind.

For one such catastrophe as that of the *Lexington*, is enough to deter thousands who would otherwise patronize steamboats with perfect confidence, from risking their lives and property on board a boat, for years. And unless some sure measures can be adopted and put in general use to render safety more certain to the public than has been the case, in very many instances, every year since steam got into general use as a motive power; this mode of conveyance and travelling ought to be totally abandoned.

But it is thought, by not a few, that most of the accidents are chargeable, in a very great degree, to neglect of duty and proper precaution, and to the want of preventive means on the part of those who own, as well as of those whose business it is to manage steamboats, and that it is fully practicable to render them as safe as any other mode of travelling.

I am not fully confident that there is any value in my hints respecting extinguishing fire by steam; but trust the reader will not impugn my motives even if he shall feel inclined to reject my theory as worthless.

If it have no other value than to draw from other and more ingenious minds some further and better views on the subject that may ultimately lead to the adoption of better modes to ensure safety, I shall feel fully compensated and highly gratified.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Description of an improvement on the Bridge patented by ITHEIL TOWNE, Esq., the term of which patent has expired. By ITHAMAR A. BEARD, Civil Engineer.*

*Elevation.*

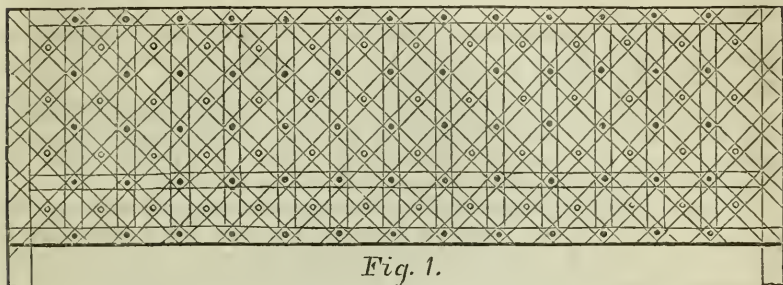
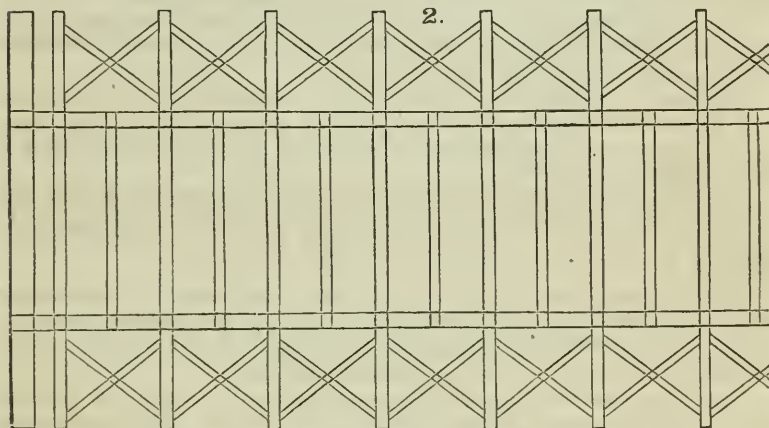
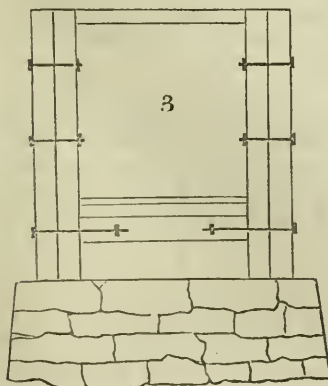


*Fig. 1.*

The Improvement consists in the Upright Plank, and the Iron Bolts.  
The Bolts are marked with a full dot (•) The Treenails marked with an open dot (◊)



Scale, twelve feet to an inch.



In 1836 I was requested to advise the best construction for a bridge to be erected over a branch of the Androscoggin river, at Brunswick, Maine, from the main land to an island.

Accordingly, I recommended Mr. Towne's bridge; and in making a model for the purpose, it occurred to me that a great addition might be made to the strength and durability of the bridge by the addition of a pair of upright planks (one on each side of the X work;) over one half the intersections, these planks to stand perpendicular like posts, and the treenails or bolts to pass through and connect the X work and the uprights at each crossing.



My object and intentions were to prevent, in the greatest possible degree, the depression of the bridge, and, on trial, I found my expectations fully realized.

This bridge is 101 feet long, in a single span, and is built with a single travel only, twelve feet wide in the clear, and the travel of the bridge is arched, or crowned, sixteen inches in the centre above a level with the ends.

For the better convenience of drafting I have made the accompanying plans level from end to end, and in fact, in a bridge of this structure I cannot see that any benefit or advantage is derived by arching.

In this bridge, instead of the ordinary treenails, the principal intersections are firmly secured with bolts made of one and a quarter inch round iron, (Bank's best,) with cast iron washers, six inches in diameter, under the heads and nuts; a single bolt being used at each intersection.

There is a vast advantage in using the bolts, with heads and nuts, over the treenails, for, it not only holds the work together more firmly at first, but it likewise furnishes the means of keeping it always firm and close, for as the woodwork shrinks by seasoning or age, as is invariably the case, even if tolerably seasoned when worked, by turning up the nuts upon the screws occasionally, it may always be kept as compact as when first built.

Another advantage is, that the bolts need not be half so large as the treenails, and fewer in number are required, which very much saves the strength of the plank through which they are inserted.

The cost of building one of these bridges with bolts instead of treenails will be somewhat greater, but for a term of twenty or thirty years, I am fully of opinion that a bridge may be supported with less expense than if built wholly with treenails.

The bridge herein described was built by Capt. James Derby who now owns the Island and Mills thereon, and the work was most thoroughly put together in every part. The using of bolts instead of treenails was his suggestion.

After the bridge was completed, and before the trussels on which it was built were taken out, I set my levelling instrument and took the elevation of the travel of the bridge in the centre, and again after the trussels were removed, and it settled seven-tenths of an inch only.

This bridge has been in constant use ever since it was built, for teaming over with heavy loads of lumber from the mills on the Island, and it now stands as perfectly firm, true, and straight as it did when first completed.

To give a more clear idea of the cost of a bridge so constructed, I will insert the number of pieces and dimensions of all the materials of which this bridge is constructed, and also the cost for materials and labour as nearly as I can obtain them.

| Timber and Plank.       |                                |   |           | Feet. |
|-------------------------|--------------------------------|---|-----------|-------|
| 8 Posts                 | 20 feet long, 16 by 16 inches. |   |           | 3413  |
| 2 Headsticks            | 18                             | " | 20 " 20 " | 1200  |
| 120 Planks for X work   | 21                             | " | 10 " 3 "  | 6300  |
| 116 Do. Uprights        | 12                             | " | 8 " 4 "   | 3712  |
| 20 Ranges of Stretchers | 101                            | " | 9 " 3 "   | 4545  |
| 15 Crossills            | 26                             | " | 9 " 6 "   | 1755  |
| 15 Do.                  | 16                             | " | 9 " 6 "   | 1030  |
| 11 Cross Caps           | 14                             | " | 8 " 8 "   | 821   |
| 22 Braces               | 16                             | " | 6 " 4 "   | 704   |

|                                                                                                                                                                                                                                                                                                                                                                        |                             |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------|
| 60 Do.                                                                                                                                                                                                                                                                                                                                                                 | 7 feet long, 6 by 4 inches. | 840       |
| Planking of the travel, 101 feet long 12 feet wide 3 inches thick                                                                                                                                                                                                                                                                                                      |                             | 3636      |
| Plank and Timber, in board measure,                                                                                                                                                                                                                                                                                                                                    |                             | 28,006    |
| Making allowance for waste, say 30,000 feet, worth here, at that time, \$15 per thousand.                                                                                                                                                                                                                                                                              |                             |           |
| All the timber of this bridge is white pine.                                                                                                                                                                                                                                                                                                                           |                             |           |
| The travel of this bridge is laid with the length of the plank lengthwise of the bridge. I do not think the plank will be so durable laid in this way as they would be if laid crosswise of the bridge, especially for heavy loads, and if planked crosswise a set of stringers must be laid on the crossills; say 5 stringers, 101 feet long 9 by 6 inches—2272 feet. |                             |           |
| Taking the lumber of this bridge as it is 30,000, a \$15 per thousand                                                                                                                                                                                                                                                                                                  |                             | \$450 00  |
| 632 cast iron washers, $3\frac{1}{4}$ pounds each, 2054 pounds a 5 cts.                                                                                                                                                                                                                                                                                                |                             | 102 70    |
| 304 Bolts 24 inches long }                                                                                                                                                                                                                                                                                                                                             |                             |           |
| 12 " 34 " " } weighing 2600 pounds.                                                                                                                                                                                                                                                                                                                                    |                             |           |
| Estimation for heads, nuts and waste 400 "                                                                                                                                                                                                                                                                                                                             |                             |           |
| Say 3000 a 10 c. including making                                                                                                                                                                                                                                                                                                                                      |                             | 300 00    |
| The labour was done by hands hired by the day, at an average of about \$1 50 each per day, board included, and cost as nearly as can be estimated, about                                                                                                                                                                                                               |                             | 375 00    |
|                                                                                                                                                                                                                                                                                                                                                                        |                             | \$1227 70 |

Equal to twelve dollars a foot in length very nearly.

It is estimated that a bridge with two travels, fifteen feet wide each, with two sidewalks outside of the  $\times$  work, and without a roof, may be built for twenty dollars a foot in length; timber and labour being at the same value as above rated.

To this must be added the cost of abutments and piers and of a roof if the bridge is to be covered.

There are no bridges in this section of country that stand so well and so durable as the "Town Bridge," and it is getting into general use.

*Brunswick, Maine, March 27, 1840.*

### *Hydraulic Works at Algiers. By M. POIREL, Engineer of Bridges and Roads.*

[Translated from the *Annales des Ponts et Chaussées* by W. H. Emory, Jr., U. S. Topl. Engrs.]

The port of Algiers was established as far back as the year 1530, by Cheredin, brother of Barbarossa. Having made himself master of a little island, in front of the city, which the Spaniards had fortified, he resolved, in order to secure it, and at the same time to make, at Algiers, a harbour that would afford protection from the winds and from the swell of the sea, to unite it to the town by means of a jetty. This is called the Cheredin jetty, and is two hundred and twenty-three yards long and one hundred and twenty-seven yards wide. Its direction is nearly east north-east; or west south-west.

Besides the Cheredin jetty, another has been built on the prolongation of the island, which protects the harbour from easterly winds, and is called the mole. It is one hundred and seventy-four yards long, and forty-five yards in its greatest width. This mole runs north-east and south-west. These two

jetties with the little mole on which the Lazaretto stands form the boundary of the basin. It contains forty thousand seven hundred and twenty-two superficial yards, and can float sixty vessels, of which about thirty, may be vessels of three hundred tons, and some few, eight hundred tons. Vessels of a larger class anchor outside the basin. The greatest depth of water is sixteen and a half feet; but this may be increased by dredging. The Cheredin jetty and the mole were found in a state of complete dilapidation when Algiers fell into the hands of the French. These two works constructed of loose stone, (sometimes called rip-rap in the United States,) were levelled to their base. The Deys were in the habit every year of having the stones replaced which were carried away in the winter by the sea.

Laugier de Tassy, one of the most faithful historians of the Algerine regency, who resided there in 1727, says:—

“The great mole (the Cheredin jetty,) being entirely exposed to the north, to prevent it from being carried away by the furious swells of the sea, which roll up the sand bank, stretching along this mole and out into the sea, they were obliged to keep the slaves of the beylick employed the whole year carrying hard stones from a place near point Pescade, to put them along the mole. The sea soon carried away the stones thus deposited, but care was always taken that they should be replaced.”

Large magazines of military supplies are placed on the Cheredin jetty and it naturally claimed the first attention of government.

The preservation of these magazines required that the loose stone upon which they rested, at the base of the jetty, should be secured.

This undertaking was confided to M. Noel, the engineer, in charge of the hydraulic works at Toulon, from which he was temporarily relieved.

He rebuilt the entire body of the jetty to a height of sixteen and a half feet above the water, with a thickness of six and a half feet. The new masonry is of the very best kind and possesses great solidity; unfortunately the insufficiency of funds placed at the disposal of the engineer and his limited time did not permit him to turn his attention to the foundation of the jetty which will soon require considerable repair.

The extremity of the mole, called the chop, in which the sea made a large breach, was repaired in 1831, but the new masonry being built upon the fragments which the action of the sea had brought down, was entirely destroyed by the first storm in the winter of 1832. All the repairs made to the top of the work were necessarily liable to the same catastrophe, as the base upon which they rested was insecure. It became necessary, therefore, before proceeding farther, to reconstruct the base permanently and durably.

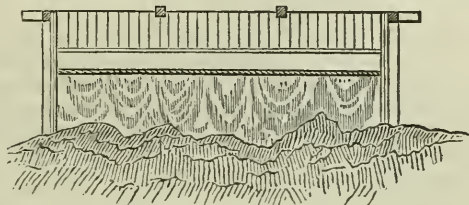
The locality did not permit the engineer's resorting to the ordinary means of establishing a foundation by throwing over loose stones, (rip-rap.) The shore to the west, where the quarries are, has not a single creek or harbour where a vessel could load; it is open to the ocean and skirted by a reef of rocks which make the landing dangerous even in a calm. The transportation of blocks of stone could only be effected by carriages, a tedious and difficult operation with masses, which, to resist the action of the waves, should measure at least four cubic yards. Besides which it would have been necessary to carry these blocks through the most frequented and populous part of the city, very much to the inconvenience of the inhabitants passing to and fro. Another difficulty presented itself, even if the obstacles to an easy transportation had been overcome. To give sufficient stability to the work at the end of the mole, a long slope of at least one in ten was necessary, which would have entirely obstructed the navigation, as the entrance to the basin was already very narrow, being



only one hundred and thirty-four yards wide, measuring from the end of the mole on which the Lazaretto stands, to that of the work in question.

Under these circumstances, the engineer was obliged to resort to other expedients, and he was thus led to form and execute a new plan for establishing foundations at sea, which five years experience of the works at Algiers has proved to be, according to all accounts, superior to all those which have heretofore been put in practice and particularly to those made of rip-rap work; a method much approved of since the construction of the Cherbourg and Plymouth breakwaters, the two most important maritime works executed in modern times.

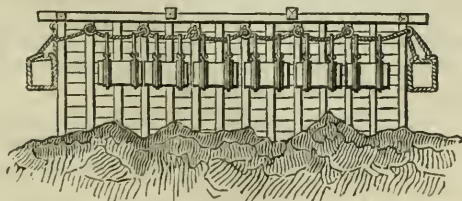
The principle feature of this plan is the use of blocks made of *béton*. These blocks are of two kinds; one being constructed in the water at the place it is intended to occupy, the other made on shore and launched.



The first is made by pouring the *béton* into cases without bottoms, sunk on the place where the block is to rest. The frames of these cases as shown in the annexed cut, are made by putting together pieces of scantling, in a rectangular form, and the sides are made by nailing to this frame two courses of plank placed at right angles to each other. The lower edges of the cases are cut out to fit the profile of the surface on which they are to rest. They are lined with tarred cloth, throughout the whole extent of the inside up to the level of the water. The cloth at the bottom is allowed sufficient fullness to accomodate itself to the inequalities of the ground. The cases are thus, in fact, converted into cloth sacks, the sides of which are strengthened by the timber work on which they are stretched and fastened. The cloth sacks enable the mass of *béton* to accomodate itself perfectly to the surface which receives it, the inequalities of which serve to bind together the rock forming the bottom, and the *béton*. This is a great advantage in the use of these cases, for with the flat bottomed ones generally used, it is necessary to level the surface to be built upon, which is a difficult and uncertain operation.

The cloth bottomed cases are built upon stocks, launched and floated to the place they are to occupy. They are then sunk by means of small wooden boxes, one foot square, filled with cannon balls or pig-iron strung entirely around on the outside of the case, about one foot and a half from the top, by means of a cable passing through iron rings fixed in the uprights.

The arrangements for sinking the cases is shown in the annexed figure.



A similar use of *béton* was made by the Italians to prevent the disinte-

gration of masonry immersed in water. They filled, with *béton*, bags similar to those used in fortification for making earth defences, and placed them compactly, one upon the other, and in such a manner as to fill up the inequalities of the surface on which they rested. The cement which oozed out through the interstices of the cloth, bound the little rolls of *béton* together and soon formed a very compact and durable mass. The cloth between the joints rotted and disappeared in a few years. On one occasion, they filled a much larger sack with *béton* than those above described, and threw it into the sea in stormy weather; some days after the storm had subsided they found this block very hard and strong. From the result of this experiment it was natural that the adoption of very large blocks of *béton* should be thought of, but the difficulty consisted in making bags of those dimensions which would not burst, and fixing them in position, while being filled with *béton*.

When the case is moored, the *béton* is lowered and deposited in it by means of a trough, which has a vertical and semi-rotary motion communicated to it by a cylinder worked at each end by a crank. This trough which contains a little more than a cubic yard, gives the advantage of putting in the case a large quantity at a time. The operation is thus made more rapid and there are fewer seams.

The *béton* blocks made on shore are moulded in cases consisting of four sides made of thick planks and lined on the inside with another course of plank jointed together at the bottom and removable at pleasure. The bottom rests upon two large sills connected transversely, forming an inclined plane which terminates at the point where the block is to be launched. These cases like the others, are entirely empty and without shores. When they are filled with *béton*, and it becomes sufficiently hard, the sides are taken off and the block thus stripped is launched into the sea.

The mortar used in the large cases with cloth bottoms, is formed of one part fat lime and two parts of Italian puzzolana; that used for blocks on shore is composed of puzzolana and sand in equal proportions.

The lime should be made from the grey transition limestone, fine grained and very hard; slaked in the ordinary way, and reduced to the consistency of thick paste, it absorbs two and a half times its weight of water. Its bulk is increased in the proportion of 1 to 1.8.

The puzzolana is the same as that used along the Mediterranean coast in the formation of hydraulic mortars. It is to be found in the neighbourhood of Rome. The best comes from Saint Paul's cave, near the church of that name. This puzzolana is brought by wagons to the Tiber, and thence by batteaux to Civita Vecchiá, whence it is exported. It is sent abroad in the natural condition in which it is found, the pieces varying in size from that of an egg to the smallest grain of sand. M. Jullien, the engineer, found by experiment that the very finest grains were the only ones that could be used with effect in hydraulic mortars, and that when it was used in grains as large, for example, as the largest grains of sea sand, it was as ineffectual as the sea sand itself. From this it appears to be necessary that the finest grained puzzolana alone should be used in hydraulic works; and as its efficacy, and quickness in hardening are in proportion to the fineness, too much pains cannot be taken to pulverize it.

Acting on this principle, the puzzolana brought from Italy to Africa for the work on the mole was sifted at Algiers before being used. One half, forming the residue, was ground in a mortar mill and sifted again, leaving a residue of one tenth.

That ground and sifted was of a quality inferior to that furnished by the

first sifting. The price of the puzzolana delivered at the work was thirty-six francs per cubic yard, and the cost of sifting, grinding, &c., twelve francs, making the total cost forty-eight francs.

The cost of labour at Algiers, independently of the inferior quality of the puzzolana obtained by trituration, and the consequent increase of expense, made it desirable that it should be sifted at Rome and the refuse left there. The soil on which this city and its environs stand, is composed of this material, and is of course very cheap. The only difference in the price would therefore arise from the cost of sifting, which could be more than balanced by the freight saved in leaving the refuse.

Influenced by these considerations, the author, on the requisition of the Governor General was authorized by the Secretary of War to repair to Rome and superintend in person, the details of the operation. He there fixed up a number of strong bolting cloths pierced with small rectangular holes. The price of sifting one cubic yard of puzzolana with labour hired of the pontifical government, was about twenty cents.

The contractor who has leased from the Roman government, the monopoly in the puzzolana trade, regarding the project as impracticable, asked an exorbitant price for taking charge of it, but as soon as he discovered it was both easy and cheap, he came forward and offered for the future to send none but the sifted puzzolana to Algiers. It was delivered there in 1837, in this state, for forty-two francs the cubic yard, and could, without doubt, be delivered for forty francs. By adding one half sand, quite as good a commodity as the rough puzzolana is produced, and you get for twenty francs what formerly cost thirty-nine. At this price this material is likely to supersede all the hydraulic lime and artificial cements made at the different localities. It is easier worked, and the quality is superior or at least equal.

Algiers is not the only place where this measure can be adopted advantageously; it can be practised with advantage on the whole Mediterranean coast and wherever the puzzolana of Italy is used. The engineers of Toulon and Marseilles have already made arrangements for the importation of the sifted puzzolana, and there is little doubt but that it will become an extensive article of traffic.

The mortar is made with one part lime in paste, and two parts puzzolana. If the puzzolana is in the rough state the mortar becomes hard in four days and resists the Vicat rod; if it is sifted through the bolting cloths it will become hard in two days, and if the puzzolana is sifted through a fine hair sieve, it will become hard in twenty-four hours.

It takes six days for mortar to become hard, which is made of one part lime, one of bolted puzzolana and one of sand.

Béton is composed of one part mortar and two of stones broken to the size of from one to two inches,\* making two parts of béton.

A cubic metre (35.317 cubic feet) of béton weighs 5886 pounds. It acquires in twenty-four hours, sufficient cohesion to withstand the shock of a heavy sea without disintegration. In November 1836, a block containing two hundred and fifty cubic yards, which had been immersed only thirty-six hours was stripped of its enclosure, and resisted the action of one of the most violent storms. M. Fénéon, a mining engineer, then at Algiers, was an eye witness of this remarkable fact.

The blocks made in the cases with cloth bottoms, measure generally from

\* Whether cubic or superficial measure, is not stated. Tr.



one hundred and eighty to two hundred and fifty cubic yards; those made on shore, from fifteen to sixty cubic yards. When constructing the mole at Algiers, they placed first a set of the large blocks, and then, in advance of them, to protect their bases, they placed a number of the second size. The large cases serve as a platform from which to launch the small blocks. The two lines of blocks are bound together at intervals by large blocks of *béton*, and these intervals are filled by stone measuring from five to eight cubic yards.

The following is an estimate of quantities and labour for a *béton* block, of thirty-six cubic yards, using mortar made of lime, sand and puzzolana:

|    |                |                       |
|----|----------------|-----------------------|
| 36 | cubic yards of | Broken stone.         |
| 12 | "              | " Puzzolana.          |
| 12 | "              | " Lime in paste.      |
| 12 | "              | " Sand.               |
| 1  | day's labour   | for a master workman. |
| 3  | "              | " three labourers.    |

The cases used cost about one hundred dollars, and one will answer for twenty blocks.

The whole cost of making and laying this *béton* at Algiers is about five dollars and seventy cents the cubic yard.

Estimate of quantities and labour for a *béton* block of one hundred and eighty-two cubic yards, sunk in a case with a tarred cloth bottom, caulked, using mortar made of lime and puzzolana:

|     |                |                  |
|-----|----------------|------------------|
| 182 | cubic yards of | Broken stone.    |
| 91  | "              | " Puzzolana.     |
| 45½ | "              | " Lime in paste. |
| 1   | master workman | three days.      |
| 2   | labourers      | for three days.  |

The construction and moving of the case cost about four hundred dollars; it can also be used twenty times.

The caulking at the angles, the cloth bottom and the removal of the case, cost about one hundred and seventy dollars.

The whole cost of making and laying this *béton* at Algiers, is estimated to be about eight dollars and seventy-five cents the cubic yard.

Colonel Emry published a work in 1831, containing many purely theoretical views, and at the same time many useful suggestions, in which he set forth, strongly, the inconveniences of the present system of building stone work in the sea, and proposed as a substitute, blocks made of *béton*.

The blocks that he proposed were also of two kinds, one kind made in the water and the other on shore; the first was to be built in a flat bottomed case, and the other he proposed to transport to the place for immersion; a plan of doubtful success; he proposed, too, that these blocks, which were to be hexagonal prisms, should be laid regularly one upon the other, which we regard as impossible.

During the execution of the new system at Algiers, some engineers thought the success of it very doubtful; but the manner in which the end of the mole stands, puts all doubt to rest. This work projects into the sea towards the quarter whence the winds blow with most violence, and it stands without having sustained the slightest injury from the most furious tempests. Besides other unquestioned advantages presented by the use of *béton* blocks instead of loose stone, the difficulty is avoided of transporting the stone of the requisite size when the quarries are remote. This consideration amounts

sometimes to an insuperable obstacle to the use of loose stone, while the *béton* can be used any where.

The Romans drew blocks of stone from Mount Circe to build the port of Anxium, a distance of ten miles; and the pontifical government was obliged to abandon the port of Auzo in consequence of the difficulty of finding a quarry in the neighbourhood, that would furnish proper stone to repair the jetties.

The Italians generally practise a mixed system. They build the foundation of loose stones, even in twenty or thirty feet water, and the top of masonry. The masonry is constructed in staunch cases, floated to the place required, and the workmen, secure from water, erect a wall usually of undressed stone and hydraulic mortar. The cases are thus sunk by degrees until they reach the loose stone. The details of this process are described in Belidor's *Hydraulic Architecture*, in his description of the manner in which the moles at Nice, Genoa and Naples were constructed.

The defects of this plan are very apparent; the bottom of the case rests upon an uneven and movable surface, and the consequence is, the masonry cracks open in many places. Moles thus constructed are soon destroyed; extensive repairs are required, which make it necessary to be continually throwing in loose stone. This is exemplified in the mole at Genoa, which shelters the harbour from the east winds, the end of which constantly requires repair.

When De Cessart projected his large conical cases, he was on the eve of discovering the simple and ingenious plan just described for establishing foundations; the great error which was committed and which fully explained the difficulty encountered by so skilful an engineer, was in supposing that a wooden structure, however substantially constructed, could resist the action of the sea. Acting on this principle, he filled his cases with small stones to keep them in place; the consequence was that when the action of the sea beat these cases to pieces, the stones fell down and the whole fabric was swept away. De Cessart should have considered the case as simply a temporary enclosure to build masonry in, which would be capable of resisting the force acting against it after the cases were destroyed. If he had taken up this idea, it would probably have led him to the use of *béton* for filling his cases. Instead of making these cases as substantially as was proposed, it would be sufficient to give them the form of a large cask without a bottom, made with uprights and staves bound together by iron chains instead of hoops, in such manner that the uprights can be taken apart when the case is to be taken up. Another indispensable condition is, that the case should be filled in the shortest possible time. The sea at Algiers is very powerful considering the little range it has; and it would be necessary to make such arrangements that a case made to contain about 1300 cubic yards, should be filled in thirty-six, or forty-eight hours. This might be done by throwing in *béton* blocks, ready made, at the same time pouring in *béton* to bind them, by means of cloth funnels fixed to the cases. This suggestion has never been acted upon, but if the intention of making Algiers a military port be carried out, there will be an opportunity of trying it on a large scale, and it is believed with complete success.

Whatever may be the fate of this or other plans for using *béton*, one thing is certain, that sooner or later, the practice of making foundations at sea with loose stone will be entirely abandoned, and masses of the natural rock so costly in quarrying and transportation, and so insufficient in dimensions, will be replaced by artificial blocks made of *béton*.

## Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN MARCH, 1839,  
*With Remarks and Exemplifications by the Editor.*

1. For a *Machine for drying Flour, &c.*; John Balantine and Adam Clark, Zanesville, Muskingum county, Ohio, March 4.

This machine consists mainly of a semi-cylindrical vessel, having a flat top which covers the semi-cylinder; this vessel is to be closed at its ends, but there are to be openings for the admission of steam, which is to pass through it. The flat side is to be placed uppermost, and is to form an inclined plane, that the flour, &c., may descend along it; there are to be ledges at the sides to keep the flour from running off.

The claim is to "the use for drying flour, and other finely divided substances, of a cylindrical segment of any length, and any chord, closed at the ends by caps, and along the chord by a plane, except a passage through the closed segment for the drying agent, as herein described; the drying agent being applied within the closed segment, under the plane, and the flour or other substance to be dried passing along the plane."

Why the claim should be limited to the segment of a cylinder, is not very evident, as it would appear that its upper and lower sides might both be planes, and made similar to the hollow drying shelves, of metal, through which steam has been made to pass, for the drying of powder, and other articles. The only novelty, if novelty it be, is the giving the inclination to the drying apparatus, for the descent of the flour.

2. For an improvement in the *Manufacture of Hat Bodies*; Hezekiah S. Miller, county of Philadelphia, Pennsylvania, March 5.

The invention consists "in a method by which fur after being carded, picked, or blown, is converted into a continuous web, lap, or sheet, for the purpose of being wound into hat bodies, so as to attain advantageously with fur the same end which has heretofore been attained in relation to wool."

By means of a fan wheel, the fur as it is delivered from a carding, or other suitable machine, is blown through a box, or trough, against a revolving cylinder covered with wire gauze, &c. From this it is taken off in a lap, being compressed by rollers, and is then ready to be wound on a former for making hat bodies. The claims are to "the combination of the fan, oblong box, or spout, and cylinder, for the purpose described; and to the combination of the two aprons operating for the purpose and in the manner described; and also these in combination with the combined fan, spout and cylinder, as described."

The resemblance between this apparatus and what has been before patented, or in use, is very close; we cannot take the time, nor do we deem it necessary to examine this point closely, the patent office having no doubt done this before granting the patent; it is to be presumed, therefore, that there was room for the claims made.

3. For a machine for *Preparing Brick Mortar*; Oran W. Seely, So-dus, Wayne county, New York, March 5.

This machine consists of a circular trough in which are two sets of wheels the peripheries of which are to roll round upon the clay contained in the circular troughs. The wheels are each to have three or four rims, or treads,



and they are placed upon a horizontal shaft which has a screw cut upon it, which passes through corresponding screws in the hubs of the wheels, by which arrangement the wheels traverse back and forth on the shaft between the periphery and centre of the tub, the shaft moving on a vertical post, rising from the middle of the tub, and the motion of the horizontal shaft being reversed, when one of the wheels arrives at the end of it. At the outsides, and between the divisions of the wheels there are scrapers to remove the clay therefrom. The claim is to "the employment of scrapers, in combination with each set of wheels." This, it will be seen, is rather a meagre claim, but we are in error if it be not still too broad. Wheels fixed precisely in the way described were patented many years since, and, most certainly, scrapers were used to remove the superfluous clay from them. The burning of the office has probably destroyed the evidence of this, but it is still, fully in the recollection of the writer.

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4. For improved *Lightning Rods*, for buildings; Joseph S. Barber, Gloucester, Essex county, Massachusetts, March 5.

This is something of a fantastical lightning conductor, the superiority of which over those in use appears to us to be the creature of imagination. A dome-like shell of copper, or other metal, is to be mounted upon a pole which passes through its centre, and gives to it the appearance of an open umbrella. The part of the pole above the dome is to be furnished with points branching out, as frequently practiced, and the lower edge of the dome is to be fringed with pieces of metal cut in the form of leaves, surrounded with numerous points. The claim is to "a paraboloid, constructed as above described, and its combination with a set of branching wire points, in the manner described, and for the purpose set forth."

Those acquainted with the early history of lightning conductors, know something of the little-endians, and the big-endians, whose differences might probably have been reconciled by the foregoing combination of a semi-globe, with sharp points.

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5. For a machine for *Planting Corn and other seeds*; David S. Rockwell, New Canaan, Fairfield county, Connecticut, March 12.

This appears to be a well arranged machine for accomplishing the intended purpose. It runs upon four wheels, and it is designed to plant two rows at once, at such distance apart as may be desired. Two boxes, called droppers, are attached to the side timbers of the machine, and these side timbers may be removed to a greater or less distance apart. The boxes, or droppers, containing the seed, have slides which are operated upon by the revolution of the wheels, and drop the grain, in quantity and distance, as may be required. The claims refer to the special construction and arrangement of these parts, to an understanding of which the drawings would be required.

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6. For a machine for *Preparing Brick Mortar*; Ansel Teal, Waterloo, Seneca county, New York, March 12.

This the inventor calls an *eccentric Mortar Machine*; and it in part resembles that described in No. 3, in having a circular trough within which the mixing instrument is to roll round, and is to move back and forth, towards and from the centre. Instead of wheels with rims, three rows of spokes are to project out from a revolving hub, placed on the horizontal shaft. The

spokes are to be so set as to tend to move the clay towards the centre of the trough, as the horse moves in one direction, and towards the circumference when moving in the opposite direction. The hub does not traverse back and forth on the shaft as in the first described machine, but there is a rack and catch, denominated a sliding gauge, which are to be managed by the attendant, when its place on the shaft is to be changed.

The claim is to "the sliding gauge, constructed as described, in combination with the hub and shaft, by which the motion of the hub, with its arms or spokes, is regulated, and they are prevented moving from the centre of the pit faster than the operator wishes."

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7. For a machine for *Cutting Shingles*; Ludlam M. Parsons, Castleton, Portland county, Maine, March 12.

A knife is to slide up and down, its ends being attached to a frame which operates like that of a saw frame within fender posts. The stuff as it is fed up to the knife bears against a vibrating pannel, allowing a head and point to be alternately cut from each end of the block. There is a contrivance for drawing the block up, and vibrating it and the pannel, and the claim made is to "the vibrating pannel, in combination with the knife, as described."

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8. For an improvement in the *Rotary Steam Engine*; Roger M. Sherman, Fairfield, Connecticut, March 12.

A patent was obtained by Mr. Sherman, on the 25th of April, 1837, for improvements in the rotary steam engine, of the same general construction with that which is the subject of the present patent. The improvement now claimed is to "the fitting of a cap to a rotary steam engine in the manner, and by the means set forth, so that the steam by its own pressure shall prevent its own escape." The manner of construction proposed is well calculated to attain its object; we, however, see no reason to dissent from the opinion we have so frequently expressed, adverse to the equality of the rotary to the reciprocating engine, as hitherto constructed. The objection to it we consider as too deeply seated to be removed by any device however ingenious, or however effective, in removing a difficulty belonging to its details, as is the case in the instance before us.

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9. For a machine for *Cutting Potatoes*, and other vegetables; Abel Williams, Ashfield, Franklin county, Massachusetts, March 12.

The novelty upon which this patent was claimed is not of a very striking character, the machine being very much like others in prior use, as will be seen by the claim. The potatoes, &c., are to be put into a hopper on the lower end of which there is a traversing slide, carrying the cutting knife for slicing, and small vertical knives for cutting through the slices; the patentee says, "I do not claim to be the inventor of the mode of cutting vegetables by means of a single edged knife attached to a gate, and cutting against a bed, with small knives having their planes and edges at right angles with the plane and edge of the main knife, such having been invented before mine. But what I do claim as my invention, and desire to secure by letters patent, is the combination of two sets of small knives as herein described, with a double edged knife attached to a gate, the whole being constructed and operating substantially as herein described."

10. For a machine for *Cutting Straw*; Charles T. Botts, city of Richmond, Virginia, March 15.

The straw is placed in a trough, and fed up towards one end of it by means of rollers, operating in a known manner. Crossing the cutting end of the trough a conical hub of cast iron revolves, carrying two cutting knives, which, by being placed on the conical hub, have a peculiar drawing motion given to their edges. Parts of the hub are cut away to make suitable seats for the knives.

The claim is to "the giving to the hub upon which the knives are affixed, the form of the frustum of a cone, in the manner, and for the purpose set forth. And it is to be understood, that by this conical form nothing more is intended than that the portion of the revolving hub, or body, to which the knives are attached, shall be so formed, as for their edges to stand in that direction, which shall cause them in their revolution to generate the frustum of a cone."

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11. For a machine for *Cutting Straw*; Thomas Hopper, New Brunswick, Somerset county, New Jersey, March 15.

In this machine there is to be a row of knives placed vertically, at such distance apart as shall correspond with the length to be given to the cut straw. The edges of these knives stand in one plane, and a roller, composed of rings of cast iron placed upon a shaft, revolves so that the peripheries of these rings shall enter the spaces between the blades. There are offsets, or teeth, projecting out from these rings, like the teeth of a saw, say five or six on each ring, and these carry the straw, which is fed on to a sloping board, against the knives, which consequently cut it. The knives are dropped into slots, which hold them in place, and by removing every other knife the length cut will be doubled. If used for corn stalks, the roller and offsets should be larger than for straw. The knives may be like common shoe maker's knives, with the handles removed.

The claim is to "the manner above described of cutting straw, and other vegetable matter, by forcing the same against a row, or series of knives, by means of a cylinder having projections thereon, which, by the aid of grooves pass between the knives or cutters, forcing the material to be cut against them."

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12. For a machine for *Thrashing and cleansing Grain*; Matthew M. McKeever, Staunton, Augusta county, Virginia, March 15.

This thrashing machine and cleansing apparatus differs but little in the manner of constructing it, or in its operation, from several others; there was nothing to claim, therefore, but the particular arrangement of the respective parts as made by the patentee. The claim is to "the combination of two fans, and their fixtures, with the thrashing machine in the manner described; to the shoot board, in combination with the straw shaker; to the shaker, and to the brace spike, or tooth, constructed as described." We do not see any thing in the matters claimed worthy of special notice.

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13. For a *Chair for Railroads*; Moncure Robinson, C. E., city of Philadelphia, March 16th.

This invention "consists in providing a chair having a shoulder on one side only, with holes or openings to receive screw bolts, which are to pass also through similar holes or openings in the ends of the rails; the holes or



openings in the rails being sufficiently long to afford the requisite play for expansion and contraction of the rails in all changes of temperature."

*Claim.*—"What I claim as my invention is the plan of attaching the ends of rails to chairs by screw bolts passing through openings in the rails, leaving open the chair on one side, and giving a shoulder to the opposite side, whereby the rail is thoroughly supported against the lateral action of engines and cars, and at the same time the means are afforded of placing and forcing the rails in line as described."

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14. For improvements in *Many chambered Fire Arms*; Elon B. Butterfield, Brattleborough, Windham county, Vermont, March 16.

The claim made is to a "block, or nut, for filling part of the space occupied by the longer cylinder, and fitting the gun to receive a rifle barrel and a shorter cylinder." The whole object of the patent is to enable the owner of the gun to substitute a rifle barrel for one of a smooth bore, the other parts of the gun remaining as before.

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15. For *Ascending Inclined Planes on Rail Roads*; William F. Ketchum, Buffalo, Erie county, New York, March 20. (See Specification.)

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16. For *Ascending Inclined Planes, on Rail Roads*; Davis H. Dotterer, and Thomas Jackson, Reading, Berks county, Pennsylvania, March 25.

The mode of ascending proposed by the patentees requires the use of a rack rail in the centre of the track. The shaft which carries the cog wheel that gears into the rack, has on its ends two flanged wheels, which run upon the rails when the locomotive is ascending an inclined plane, but are raised from their bearing, by a suitable contrivance, when not so employed, the cog wheel being at the same time disengaged from the rack. The two wheels last spoken of are denominated power wheels, they are smaller than the ordinary driving wheels, and of such diameter as to prevent the teeth of the cog wheel from bottoming in the rack. They are driven by connecting rods from the driving wheels, which then act as fly wheels, being raised above the rails.

*Claim.*—"The locating of the two wheels, which we have denominated flanged power wheels, in the rear of the locomotive engine, behind the ordinary driving wheels, providing the means of raising and lowering such wheels so as to bring a cog wheel affixed on the centre of the same axle, into gear with a rack rail, and to raise the driving wheels clear of the track, for the purpose of enabling such locomotive with the train attached to it, to ascend inclined planes by the operation of the ordinary power of the engine."

There is considerable skill displayed in the plan devised by these patentees, but we apprehend that the objections to the employment of rack wheels on inclined planes are too serious to admit of their adoption.

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17. For a machine for *Cutting Shingles*; J. Hinman, J. Thatcher, and A. Palmer, Persia, Cattaraugus county, New York, March 25.

This invention is said to consist "in making shingles from timber in its natural state by cutting them longitudinal from the bolts, or blocks, of the requisite length for the shingles, by a reciprocating knife, placed obliquely, or at right angles, with the slide, or carriage, to which it is attached, operat-

ing parallel, or nearly so, with the grain of timber, according to the angle of the knife."

The claims made are to "the carriage, or table, constructed with two movable platforms at the upper side, placed at opposite ends, with their sides depressed as much as to give the requisite thickness and taper to the shingles; the opposite platforms having their opposite sides reversed, in combination with the two edged knife, as set forth."

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18. For a *Smut Machine*; William C. Grimes, York, York county, Pennsylvania, March 25.

This machine consists mainly of two vertical cylinders, the innermost revolving within the outer cylinder, or case, as in many other machines for the same purpose; there is, however, a strong characteristic difference from others in the arrangement of the acting parts; among these is the causing "a current of air to pass upwards between the two cylinders, with a degree of force sufficient to carry off all the foreign matter through an opening left for that purpose in the upper part of the machine, whilst the cleaned grain, from its superior gravity, descends and passes out at the bottom of the apparatus. The claim is to the manner of producing a strong upward current of air; the devices for which would require the drawings, or a more lengthened description than we can afford for their explanation. There are some other claims which are in the same predicament, we therefore dismiss the subject with observing that we have heard a very good character of this machine given by those who have made trial of it.

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19. For a *Thashing and Hulling Machine*; Thomas Elliot, Middleton, Jefferson county, Kentucky, March 26.

This machine is said to be for "thrashing all kinds of small grain, for shelling corn, hulling clover seed, and for cutting straw." As may well be supposed, some parts of the machine must be removed and others substituted for them, to adapt it to the various purposes to which it is be applied. The specification is necessarily one of great length, referring to the respective parts in the drawings. The claims refer to the different devices employed, and we shall therefore omit them, as not aiding in the description. Whether the changes to be made are such as still leave the machine in possession of the character of individuality, may admit of some doubt; the law gives a patent for any new machine; but there have been many cases in which a patent has been refused where such a change was proposed to be made in a machine as would constitute it, essentially, another machine, applicable to a new purpose; such it seems was not the judgment of the office in the case before us.

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20. For a machine for *Shelling Corn*; W. McElroy, Jr., and B. and W. Boon, Greenwich, Warren county, New Jersey, March 30.

This machine is, in its general construction, similar to that first invented and patented for shelling corn; the effect being produced by feeding the corn between a revolving cylinder set with teeth, and a concave which in part surrounds the cylinder. There are, however, some new devices employed, in the particular manner of constructing the concave, and regulating its yielding, so as to adapt itself to ears of different sizes. The concave is denominated a "back," and the claim is to "the mode described of sustaining and regulating the self-acting back, by the combined action of the straps, &c., and the lower spring, or springs."

21. For a *Tailor's Draughting Instrument*; Edward Axford, city of Philadelphia, March 30.

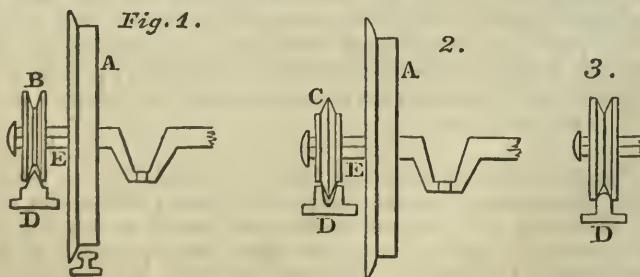
The specification of this patent extends through eleven pages of record, describing the draughting instrument, which contains the ordinary square, with several additional arms, and numerous scales; and this is accompanied by diagrams illustrative of the mode of using the instrument. We freely confess our entire incompetence to undertake the analysis of this matter, which seems to us so recondite, as to belong to the initiated only. We have no doubt, however, respecting the cleverness of the whole matter, from the known character, and handiwork of the patentee.

#### SPECIFICATIONS OF AMERICAN PATENTS.

*Specification of a Patent for a method of enabling Locomotive Engines and their trains to ascend Inclined Planes, on Rail-roads; granted to WILLIAM F. KETCHUM, Buffalo, Erie county, New York, March 20th, 1839.*

To all whom it may concern: Be it known, that I, William F. Ketchum, of the city of Buffalo, in the county of Erie, and state of New York, have invented an improvement in the mode of constructing the wheels of Locomotive engines, and of rails adapted to such wheels, by the aid of which, locomotives with the trains attached to them, may be made to ascend inclined planes, the adhesion of the wheels to the rails being increased, without the employment of cogs, whilst said wheels may be reduced in size to any desirable extent, thus increasing the power of ascent in the same ratio; and I do hereby declare that the following is a full and exact description thereof.

The ordinary driving wheels of the locomotive engine are made in the usual way, but on the same axis on which two ordinary wheels are fixed, I place another pair of wheels, on the outside of these ordinary wheels. The additional wheels may be made of such diameter as will adapt them to the grade of the inclined plane up which they are to ascend. The peripheries of these wheels are to be grooved, or channeled, in the manner of those pulleys, or wheels, which are to receive a rope, or chain; the form of the groove, or channel, may vary, but I most commonly sink it so as to form a V groove, but this is not a point of importance.



The wheels, constructed as above, are to run upon rails adapted to them, placed on a line with, and outside of the ordinary rails of the track, and raised above the ordinary rails to a height sufficient to raise the ordinary wheels above them, so that they may revolve freely without coming into contact with any thing. The rails adapted to the grooved wheels are to be ridge formed, so as to fit into the grooves of the wheels, and so that the sides



the grooves may bind upon them in any desired degree. It will be readily perceived that the form of the groove and of the rail may be varied in any manner consistent with the main object of the construction, namely, that of causing the one forcibly to embrace the other. It will also be evident that the same principle may be varied by forming the groove in the rail, and the ridge upon the wheel; but this arrangement would be objectionable, as the grooved rail would retain any substance which might fall, or be placed within it. The extra wheels are to have some lateral play to adapt them to the unavoidable inequalities of the rails; and to admit of this I make the portion of the axis upon which they are placed, and the holes through the centres of the wheels, polygonal; or, if round, I check them from turning and allow them to play laterally, by means of a feather.

In the accompanying drawing A, A, figs. 1 and 2, represent the ordinary driving wheels, and B, C, the extra wheels, B, being grooved, and C, ridged, the rails, D, D, upon which they run, being made of a corresponding form. Fig. 3, shows that the rail D, though differing greatly from those in fig. 1 and 2, in its form, may still be forcibly embraced by the groove made in the wheel.

By placing the additional wheels on the outside of the ordinary driving wheels, I am enabled to vary their size from an equality with that of the driving wheels, to the smallest diameter at which they can be eligibly used on the steepest ascents. They can also be readily removed, and those of other sizes substituted for them, should it be desired, or they may be left off when it is desired to allow the driving wheels to run upon the ordinary rails.

I do not claim to be the inventor of the mode of increasing adhesion of wheels to the rails by making one of them with a ridge and the other with a groove, this having been previously done, the extra wheels for this purpose having been placed on the insides of the driving wheels; but what I do claim is an improvement in the manner of using such wheels, by placing them outside of the driving wheels, by which change they are much better adapted to the intended purpose than placed on the inside, as their diameters may be varied to any desirable extent; whilst, also, they may be readily removed, or others may be substituted for them, as above specified.

WILLIAM F. KETCHUM.

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SPECIFICATIONS OF ENGLISH PATENTS.

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*Specification of a patent granted to WILLIAM WATSON, Junior, of the county of York, for an invention of certain improvements in the manufacture of liquid ammonia, by which the same may be made applicable to the purposes of dyeing, scouring, and other manufacturing processes.*—[Sealed 20th November, 1838.]

My improvements, in the manufacture of liquid ammonia, by which the same may be made applicable to the purposes of dyeing, scouring, and other manufacturing processes, consist in a more economical method of manufacturing it; but although I do not profess to make a pure solution of ammonia, I do make it pure enough for the purposes of dyeing, scouring, and other manufacturing processes: and again, although it is impure, it is entirely and distinctly a different thing from the impure solutions before used, and which are commonly called ammonia liquor, or gas liquor, or gas water;

and also from such partially purified solutions of ammonia as are made from these, for the purpose of making cudbear, or archill, which, however applicable to such purposes, have not hitherto been used in the processes of dyeing and scouring: but, in order to specify distinctly the process or method which I have invented for the manufacture of liquid ammonia, or what is commonly called ammonia, it may be needful to state that the impure solutions of ammonia are obtained from the distillation of bones and other animal matter; and also from coal, in the making of coal gas; but in this state it is connected with so many other substances, such as oil, tar, carbonic acid, &c., as to render it quite inapplicable to any useful purpose.

In order, therefore, to separate the ammonia from its impurities, it has hitherto generally been the practice to combine it with sulphuric or muriatic acid, which, by evaporation, produces the salts of sulphate, or muriate, of ammonia; and these salts are still further purified by exposure to heat, or by re-crystallization.

The impurities being thus removed, the ammoniacal salt is put into a retort or boiler, along with fresh slacked lime, and from this mixture is expelled a gaseous ammonia, which being passed into water is absorbed, and forms the liquid ammonia.

In the process, which I have invented, I manufacture the liquid ammonia from gas water, and I dispense entirely with the use of sulphuric or muriatic acid, and of course with the evaporation and crystallization. I make it in the following manner:—the gas liquor, or gas water, collected at coal gas works, I put into a retort, or any other suitable vessel, along with fresh slacked lime, the quantity of which is to be determined by the quality of the water, and, by the application of heat, a tolerably pure ammoniacal gas is disengaged, which, being passed into water, forms a solution of ammonia.

When this distillation has been carried so far, that a considerable portion of steam, or the vapour of water, proceeds from the retort along with the ammonia, the ammoniacal solution, already formed, is to be removed,—this I call the first portion; and what is collected afterwards by a continuation of the process, I call the second portion; and, being very impure, it is put back into the retort with the next charge of gas water.

The first portion must be again submitted to distillation, with or without a small quantity of lime, and the same precaution must be observed as before, that is, so long as the principal part of what proceeds from the retort or boiler is ammoniacal gas, it must be passed into water; and when this ceases to be the case, as by continuing the heat, the water as well as the ammonia will evaporate, which may be known by the pipes or worm that are connected with the retort, and through which the steam passes, becoming heated by the condensation of it,—the solution of ammonia, already formed, must be removed;—this may be called the first portion of the second distillation. The process may be continued then until all, or nearly all of the ammonia is distilled; this second portion is to be returned as before to the retort.

The first portion of this second distillation is a solution of ammonia, sufficiently pure for common purposes; but it may be still further purified by distilling it a third time in the same manner as before, preserving for use or sale that portion only which is made by the absorption of the ammoniacal gas (or what is principally ammoniacal gas) in water, and returning to the retort the latter portions of the process, which consist of ammonia and water that has been distilled from the retort, and brought along with them a considerable quantity of impurities.—[*Inrolled May, 1839.*]

*Specification of a patent granted to THOMAS ROBERT SEWELL, of the county of Nottingham, for his invention of certain improvements in manufacturing white lead.*—[Sealed 14th July, 1838.]

My invention of improvements in manufacturing white lead consists in the four following particulars:—first, a peculiar mode of manufacturing an oxide of lead, which will be found more suitable for conversion into white lead than those oxides known in commerce under the names of litharge and massicot; second, the production of a superior quality of white lead, into the composition of which a larger proportion of metallic lead, or a smaller proportion of carbonic acid enters, than into an equal weight of carbonate of lead produced by the ordinary modes of precipitation; third, the employment of carbonic acid obtained in a state which is better adapted to the manufacture of white lead than that evolved in the combustion of charcoal, or other carbonaceous matters in atmospheric air; and fourth, a superior mode of operating in order to abstract from the white lead the matters with which it may be in a state of mixture at the time of its production.

The mode in which I manufacture the oxide of lead, forming the first head of my invention, is this:—I take the partially oxidized lead, obtained in the ordinary mode of making red lead, at that point of the process which immediately precedes its introduction into the oven to be converted into red lead. This preparation I have found to consist of a portion of metallic lead, protoxide of lead, and some red lead. I place these materials in an oven similarly constructed to those usually employed in the manufacturing red lead; in which oven, or other convenient receptacle, I submit it to a moderately red heat for about three or four hours. During this time it must be frequently stirred with an iron rake, or other suitable apparatus, in order to expose all the parts equally to the action of the heat. This process of heating, owing to the high temperature, instead of converting the materials into red lead, decomposes all the particles of the red lead, oxidizes the metallic lead, and brings the whole to the state of protoxide of lead, which is the substance required. Whilst the protoxide is in this highly heated state, it is to be expeditiously removed from the oven into a vessel, and closed up from the action of the atmosphere until cold, when it has become fit for use.

I have now two modes of effecting the second head of my invention, either of which I can employ. One of these modes is, by precipitating the white lead from solutions of oxide of lead, by means of alkali or alkalies, in combination with proper portions of carbonic acid: the other is by precipitating white lead from solutions of oxide of lead, by means of carbonic acid, obtained in manner hereinafter to be described, under the third head of my invention.

In order to precipitate white lead by the first mentioned method, I take a quantity of protoxide of lead, dissolved either in dilute nitric or acetic acid, which solution may be either in the state of dinitrate, trisnitrate, diacetate, or trisacetate of lead: the two latter I prefer; which, being substances well known to chemists, need no further description. To any one of these I add potash, soda, or ammonia, (which I prefer to be in a state of solution) in quantity just sufficient to neutralize the acid of the solution of oxide, and which alkaline materials must be previously in combination with as much carbonic acid as will be sufficient to convert the oxide of lead into dicarbonate of lead; but not enough to convert that oxide into carbonate of lead.

To ensure a similar result when I employ the carbonic acid in the state described under the third head of my invention, I pass such carbonic acid



through a mixture of oxide of lead, in a solution of acetic acid, or acetate of lead, or through a solution of diacetate of lead, or of triacetate of lead, or through a mixture of any of these materials,—and agitate the mixture during the passage of the gas, but stop the supply of carbonic acid in a very few minutes after the liquid arrives at such a state as would produce an acid reaction upon blue litmus paper, when dipped into it.

Under the third head of my invention, the carbonic acid which I employ, may be obtained from either of the five different combinations of materials about to be described.—First, one part of charcoal, coke-dust, or any other similar carbonaceous matters, with about seven parts of sulphate of lime, well ground, and intimately mixed together:—second, one part of charcoal, or coke-dust, &c., with about ten parts of sulphate of barytes, well ground and mixed as above:—third, one part of charcoal, &c., with about eight parts of sulphate of strontia, well ground and mixed:—fourth, three parts of charcoal, &c., with about fifty parts of carbonate of lime, and one hundred and twenty parts of sulphuret of lead, well ground and mixed.

Either of the above combinations of materials are to be placed in a retort of the same construction as those used for distilling coal in the ordinary production of illuminating gas. The retort being heated to a bright red must be continued at that temperature as long as any gas can be generated, and the gas conducted into an hydraulic main, kept constantly supplied with water, and thence into a gas-holder, from which it may be pumped, or otherwise forced through a vessel of water, and brought into contact with the materials about to be converted into white lead.

The fifth mode of producing carbonic acid gas is, by placing charcoal, or coke, or other similar carbonaceous matters, broken into small pieces, in an earthen retort, and when heated to a bright red, passing a current of steam through the materials in the retort, which will cause the steam to be decomposed, and carbonic acid gas to be produced, with small portions of other gases not injurious to the subsequent operation of making white lead. These gases are to be collected in a gas-holder, and applied in the manner before described.

The improved mode of washing white lead, which forms the fourth head of my invention, is effected under pressure.

White lead is produced in various ways, but most frequently in a state of admixture with acids and other matters, which it is necessary to remove by washing in water previously to the white lead being dried and prepared for market. This operation of washing has to be repeated several times in large volumes of water, and when it is desired to recover the acids and other matters so washed away from the lead, the very great quantity of water which must be evaporated in concentrating the matters contained in the water renders the operation difficult and expensive. To obviate this inconvenience, I perform the washing of the lead under either pneumatic or hydrostatic pressure, by which means I am enabled to cleanse the lead effectually by a comparatively small quantity of water, and also to save much of the time usually required for the lead to subside.\*

*Jour. Arts & Sci.*

\* The apparatus employed by the patentee is figured in *Newton's Jour.* for November, 1839.

*Specification of a patent granted to WILLIAM WATSON, Junior, of the county of York, for certain improvements in the manufacture of materials used in the dyeing of blue and other colours.*—[Sealed 8th November, 1838.]

My improvements, in the manufacture of materials used in the dyeing of blue and other colours, consist in certain processes of preparing indigo, in order to render it more applicable to the purposes of dyeing wool, cotton, silk, and other similar materials, either in the raw or manufactured state; and also in adapting such materials to the general demand of commerce and manufactures upon a large scale.

In order that the improvements may be more readily understood, I deem it necessary to describe one ordinary manner of operating upon indigo, to improve its colour, and make it more available for the purposes of dyeing, which has hitherto been as follows:—the indigo is ordinarily dissolved in sulphuric acid, and by filtering the solution, which has been previously diluted with water, the grosser and impure parts of the indigo are separated from the finer; to this filtered solution is afterwards added some salt or alkali, which precipitates the blue colouring matter in combination with the sulphuric acid; the precipitate being collected upon a filter, is now of the consistency of paste, and known in commerce as “extract of indigo.”

The excess of uncombined acid which this produce contains, is sometimes, for still further improvement of the colour, and also for the convenience of dyers, removed by various operations, the details of which it is not necessary here to pursue.

Now my improvement in this process,—and in order to ensure the complete neutralization of the acid, thus rendering the colour more beautiful and pure, and securing the absence of all free uncombined acid,—is as follows:—I employ the hydrate of alumina in the manufacture of “extract of indigo,” and in the following simple manner:—when the indigo has been dissolved in sulphuric acid, passed through the process already described, and the uncombined acid removed, as much as possible, by the ordinary means, I add to it hydrate of alumina, or alum, and ammonia potash, or soda, or any other materials, which, by their mutual decomposition, produce the hydrate of alumina; and, after mixing these well together, I place the mixture upon a filter, and allow it to remain until the paste is of sufficient consistency for sale or use.

Another method I employ, in order to improve the colour and quality of indigo to be used for dyeing, is lime, or orpiment and lime, or by other agents, by which indigo may be dissolved in *water*, such as potash, soda, or ammonia, fin-wood, &c.; and when such solution is made, it is allowed to remain at rest until the insoluble part of the indigo, and materials employed, have subsided; I then draw off the clear liquor, and, by exposing it to the action of the atmosphere, the blue colouring matter of the indigo is precipitated, which precipitate is to be collected upon a filter, mixed with diluted sulphuric, or muriatic, or any other acid, washed with water, and lastly dried; by which refining process I produce a beautiful and very pure indigo.

And also for a still further improvement of the colour of indigo, and for the more convenient use of it, I take indigo, refined by the process just described, and dissolve it in concentrated sulphuric acid, and this solution of refined or purified indigo, in sulphuric acid, I call *liquid* extract of indigo.

Lastly, I desire it to be understood, that I do not intend to claim such common or known processes as have been above alluded to, but the adaptation of such process or processes, upon a large scale, for the purpose of com-

merce and manufactures, and applying the product to the purposes of dyeing ; and also the manufacture and application of liquid extract of indigo to the purposes of dyeing wool, woollen cloths, silk, cotton, or other goods, or materials.—[*Inrolled May, 1839.*]

Ibid.

*Specification of a patent granted to JOSEPH DAVIES, of the county of Surrey, for his invention of a composition for protecting wood from flame.*—[Sealed 13th August, 1838.]

My invention is a composition of the substances hereinafter mentioned, combined with glue or size, or other animal gelatinous matter in manner hereinafter stated. The substances used are slate, slate dust, stones, sand, clay, and earth ; any of these substances may be used separately, or any or all of them may be used together. All articles made and consisting of any of these substances, such as earthenware or bricks, may be used, but I prefer slate or slate dust ; and when I use clay or earth, I mix sand or slate dust with it, as I find a composition binds better when so mixed.

Before using any of the above substances which are not already in a state of powder, I reduce them to powder by grinding in a mill, or otherwise. I boil the substance or substances with the glue or size, or other animal gelatinous matter, in a boiler, pot, or pan, frequently stirring the composition until the whole becomes thoroughly amalgamated, and of a proper consistency for use. I find that the proportion of one-twentieth of the gelatinous matter to the quantity of the substance or substances used, produces the best and most effectual composition ; but an inferior composition may be made with a less proportion of gelatinous matter.

I apply my composition to the wood with a trowel or other suitable instrument, in the same manner as common stucco or plaster, in such thickness as may be deemed necessary :—in ordinary cases, for ceilings and floorings, I make it from half an inch to an inch in thickness, and thinner in places less exposed to danger. The composition may be applied immediately in the state in which it is taken from the boiler, but if it is not required for immediate use, it should be suffered to cool and dry, and it should be again reduced to powder, by grinding or otherwise, before it is used ; it is then to be mixed with water, as in making common mortar.

Ibid.

#### **Progress of Practical and Theoretical Mechanics and Chemistry.**

##### *On the theory of the Formation of White Lead. By MR. BENSON.*

The carbonate of lead formed by the common process, is anhydrous, amorphous, and contains one proportional each of carbonic acid, oxygen, and lead. In order to explain my views (says the writer,) I shall have to advert, for a moment, to the oxide of lead, termed litharge. Litharge is seldom manufactured with a view to its ulterior application, as it is produced as a secondary product in the separation of silver from lead, even under Mr. Pattison's arrangement, in quantities too large for the demands of commerce. A considerable proportion of the litharge made must, therefore, necessarily be reduced again into the metallic state, and, during this reduction, seven per cent. of the weight of the metallic lead is lost by sublimation, and by combining with the earthy matter of the coal. Now, as litharge is a pro-



toxide of lead, it has been thought, that in order to effect its conversion into white lead, nothing more was requisite than to combine it with a due proportion of carbonic acid; and from this mistake, a variety of fallacious processes have been projected. The processes to which I allude, are founded upon bringing the litharge into solution as a basic salt, and then precipitating it as a carbonate by the injection of carbonic acid. Painters maintained, that this precipitate was not white lead. Chemists, finding, by analysis, the correct proportions of protoxide of lead and carbonic acid, attributed the opinion of painters to prejudice. Dr. Ure was, I believe, the first to discover in what the difference between the precipitated carbonate and white lead consisted. I have already sated, that white lead produced by the usual mode of manufacture is amorphous, and in oil, opaque; whilst, by microscopic observations, Dr. Ure has ascertained, that the former is semi-crystalline, and, to a certain degree, transparent. The difference between white lead and precipitated carbonate may be illustrated by comparing them to pulverized chalk and powdered marble; both are carbonates, but the one is crystalline, the other is not, and one is, consequently, less opaque than the other; and this difference is, of course, more appreciable, when the powders are diffused through highly refracting media, such as oil. There is one mode by which this difficulty may be avoided, and this was arrived at previously to the discovery of Dr. Ure, as a deduction from a different train of reasoning. The rationale of both the processes, of that which produces the crystalline, and of that which produces the amorphous carbonate, is the same. In both, the lead is converted into basic acetate—in both, the salt is decomposed by carbonic acid, but in the former the process is modified by the pressure of water. In the one, the carbonate has been deposited from a solution—in the other, the particles, never having departed from the solid state, have not been at liberty to arrange themselves symmetrically. In order, therefore, to produce amorphous carbonate, or white lead, from litharge, it became necessary to present the oxide of lead with a quantity of acetic acid so minute, that an insoluble basic salt should be formed, with a quantity of moisture merely sufficient to determine the action of the carbonic acid. The process would then resemble, in all respects, the ordinary one, except that in the one the lead has been previously converted into oxide, in the other, the formation of the oxide goes on simultaneously with that of the carbonate. The process has been carried out on a scale of considerable magnitude at Birmingham Heath. The quantity of acetic acid used is less than 1.300th of the weight of the litharge, and the quantity of moisture found to be most advantageous is such as will just render the litharge sensibly damp to the touch. A purer and more economical source of carbonic acid than bark has been found in the combustion of coke, and powerful machinery has been applied to facilitating the process, by exposing new surfaces to the action of the gas. The result has been, that the process is completed in as many days as the ordinary one requires months, and the product is of a purer white, and in opacity or body, and all other respects, at least equal to the usual white lead of commerce. One or two other facts deserve mention, which are not generally known. It is singular, that if the protoxide of lead known as massicot, and the protoxide known as litharge, be exposed to a high temperature, approaching to a red heat, the massicot will rapidly absorb oxygen, and become the ordinary red lead of commerce; while the same process goes on exceedingly slowly with the litharge, if at all; but, on the other hand, if massicot and litharge be moistened with dilute acetic acid, and exposed to carbonic acid, the litharge will

be converted into carbonate before the massicot is much affected. Another fact is, that white lead and oil combined with so much energy, that if linseed oil be poured upon a large quantity of white lead, and the mass be left undisturbed for a few hours, the temperature will become so elevated, as to carbonize the oil, and render the whole perfectly black. It seems also not generally known, that white lead possesses the power of destroying the colouring matter of linseed oil. If sulphate of barytes be mixed with one portion of oil, and white lead with another portion, the latter will appear comparatively white. If the two mixtures be allowed to remain for some days undisturbed, a quantity of oil will gradually rise to the surface of both. In the former, the supernatant oil will have undergone no change—in the latter, the oil will be nearly deprived of colour, and will have acquired the degree of rancidity, termed by painters, fat. The colouring matter has not combined, as might have been expected, with the white lead, for if this be dissolved by the agency of a weak acid, the disengaged oil will also be found to have been bleached. A large quantity of white lead is required to produce this effect, and the precipitated carbonate is less efficient than the white lead of commerce.

Athenæum.

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*On the best means for Burning Gas for Supplying Heat.* By SIR JOHN ROBISON, K. H., Sec. R. S. E., M. S. A.

When carburetted hydrogen gas is employed in procuring heat, it is seldom required that it should at the same time give out light; the combustion may therefore be managed in any way which may be convenient, without seeking to preserve the illuminating power.

It appears to have occurred about the same period to the late Dr. Duncan and to myself, that, by passing a current of gas mixed with atmospheric air through a wide vertical tube having its upper end covered by a diaphragm of wire gauze, and by kindling the mixture as it escaped through the interstices of the wire cloth, a convenient stove might be formed for culinary purposes. Dr. Duncan applied some small apparatus on this principle to pharmaceutical operations in his class room; and I had my kitchen furnished with a range of large stoves which were intended to supersede the use of French charcoal stoves in various culinary processes. In both cases the success has been perfect, and the same principle has since been adopted with advantage in a variety of processes in the useful arts, where this neat and cleanly method of applying heat has rendered it a valuable acquisition to the workshop. The form of the apparatus may be varied in any way to suit the particular process to which it is to be supplied; as all that is essential is, that a current of the mixed gas and air shall rise through wire cloth, and that the proportion of gas to atmospheric air shall never be so great as to allow of the flame becoming yellow, as with this precaution, the combustion of the carburetted hydrogen will be complete, and no deposit of soot will take place on cold bodies when set over the flames. The proper quantity of gas in the mixture is easily determined by the stopcock belonging to each stove.

For ordinary culinary purposes, the cylinders may be 30 inches long, and 3 to 4 inches diameter, and the wire cloth for the tops should have about thirty-wires to the inch. That which is manufactured for safety lamps answers well for this purpose.

Whenever, from accidental injury, or decay, a hole takes place in a

diaphragm, it is no longer possible to use it, as when lighted, the flame passes through the fracture and communicates with the jet at the bottom of the cylinder, which then burns like an ordinary gas light, and like it, would blacken the surface of any cold body presented to it. The wire cloths, if not broken through by violence, will last for months, although in daily use, and if covered by a layer of coarse sand, or pounded limestone will continue serviceable for an unlimited period.

When more intense heat is required than is attainable by the unaided combustion of the mixed gases, recourse may be had to various forms of blow pipes; and when a large volume of such flame is to be employed, the current of atmospheric air may be urged by double bellows. A very efficient apparatus on this principle is to be seen in the laboratory of Dr. D. B. Reid.

It is to be regretted that such applications of gas are not more generally known and introduced into workshops, as there are numerous processes in the arts in which they would afford facilities to the workman which he can scarcely command by any other means; for example, in the hardening of steel tools, it is well known that a piece of bright steel when heated to redness in a forge, or muffle, is subject to oxidation, and that a black scale remains after hardening, which it is difficult to remove without some injury to the work, as in the case of a screw tap; whereas, if the same piece of steel be heated in a flame of the mixed gasses, where there is no free oxygen to attack its surface, it may be *made and kept* red hot without any injury to its finest edge; it will be discoloured, but without losing much of its polish. The artist has also the advantage of a distinct view of the article while it is being heated, and the power of withdrawing it from the flame the moment it has acquired the proper colour, which in the hardening of cast-steel cutting tools is of great importance.

Many attempts have been made to apply carburetted hydrogen and pure hydrogen gases to the purpose of warming buildings, and a variety of forms of stoves have been proposed, on the understanding, it would appear, that, by applying the flame of the gas to metallic bodies, an increased degree of heat would be communicated by them to the atmosphere around them; a little consideration will show, that however the *distribution* of the heat may be modified by such contrivances, there can be no increase of the heating power; and that when a certain measure of gas is fairly burned, the heat evolved into the apartment will be the same whether the flame be disposed as a light or made to play against metallic plates, or other combinations of apparatus. In all cases where the products of the combustion are allowed to mix with the atmosphere of the apartment, without provision being made for carrying them off by ventilation, the effects of such processes must be more or less deleterious to health according to the proportion these products bear to the mass of air they mix in.

On the whole, it may be assumed that this mode of heating apartments is the most expensive, the least efficient, and, excepting that by Joyce's charcoal stove, the most insalubrious that can be resorted to.

Lond Mech. Mag.

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*On the Application of Electro magnetism as a Motive Power: in a letter from Prof. P. FORBES of Aberdeen, to MICHAEL FARADAY, D. C. L., &c. &c.\**

*King's College, Aberdeen, Oct. 7, 1839.*

My dear Sir,—Having seen a notice from Mr. Jacobi sent by you to the London and Edinburgh Philosophical Magazine,† regarding the success of

\* Communicated by Dr. Faraday. † See L. & E. Philos. Mag. for Sept., p. 164.



his experiments on the production of a moving power by electro-magnetism, I am sure it will give you pleasure to know that a countryman of our own, Mr. Robert Davidson, of this place, has been eminently successful in his labours in the same field of discovery. For in the first place, he has an arrangement by which with only two electro-magnets and less than one square foot of zinc surface (the negative metal being copper) a lathe is driven with such velocity as to be capable of turning small articles. Secondly, he has another arrangement, by which, with the same small extent of galvanic power, a small carriage is driven on which two persons were carried along a very coarse wooden floor of a room. And he has a third arrangement, not yet completed, by which, from the imperfect experiments he has made, he expects to gain very considerably more force from the same extent of galvanic power than from either of the other two.

The first two of these arrangements were seen in operation by Dr. Fleming, Professor of Natural Philosophy in this University, and myself, some days ago; and there remains no doubt on our minds that Mr. Davidson's arrangements will, when finished, be found available as a highly useful, efficient, and exceedingly simple moving power. He has been busily employed for the last two years in his attempts to perfect his machines, during all which time I have been acquainted with his progress, and can bear testimony to the great ingenuity he has shown in overcoming the numberless difficulties he has had to encounter. So far as I know, he was the first who employed the electro-magnetic power in producing motion by simply suspending the magnetism without a change of the poles. This he accomplished about two years ago. About the same time he also constructed galvanic batteries on Professor Daniell's plan by substituting a particular sort of canvas instead of gut, which substitution answers perfectly, is very durable, and can be made of any form or size. And lastly, he has ascertained the kind of iron, and the mode of working it into the best state for producing the strongest magnets with certainty.

The first two machines, seen in operation by Dr. Fleming and myself, are exceedingly simple, without indeed the least complexity, and therefore easily manageable, and not liable to derangement. They also take up very little room. As yet the extent of power of which they are capable has not been at all ascertained, as the size of battery employed is so trifling and the magnets so few; but from what can be judged by what is already done, it seems to be probable that a very great power, in no degree even inferior to that of steam, but much more manageable, much less expensive, and occupying greatly less space, if the coals be taken into account, may be obtained.

In short, the inventions of Mr. Davidson seem to be so interesting to rail-road proprietors in particular, that it would be much for their interest to take up the subject, and be at the expense of making the experiments necessary to bring this power into operation on the great scale, which indeed would be very trifling to a company, while it is very serious for an individual by no means rich, and who has already expended so much of his time and money for the mere desire of perfecting machines which he expected would be so beneficial to his country and to mankind. For it deserves to be mentioned that he has made no secret of his operations, but has shown and explained all that he has done to every one who wished it. His motives have been quite disinterested, and I shall deem it a reproach to our country and countrymen if he be allowed to languish in obscurity, and not

have an opportunity afforded him of perfecting his inventions and bringing them into operation, when they promise to be productive of such incalculable advantages.

L. & E. Philos. Mag.

### *New Variety of Carbon.*

A specimen of the incrustation on the interior of a gas retort was produced; it was a coke of extreme density and of great value for some purposes, but for what was a secret. This deposition accumulates until the interior of the retort is almost filled up, leaving no available space for the charge. The retorts are bought for the sake of this coke, which is a perfect carbon. A thin coating of carbonaceous matter, which would otherwise be carried off in the gas, is deposited in each charge.

Mr. Lowe was not aware of the uses to which this coke could be applied; but it was of extreme disuse to the gas-makers; he believed, however, that it was used to produce an intense heat. It is sometimes stated to be a carburet of iron, but a portion from the centre of the mass shews, on being tested, not the least trace of iron. It arises naturally in the process of gas-making, and the rate of its deposition depends on the temperature; as in those retorts which have a tendency to become too hot the deposition goes on exceedingly fast. There were many curious facts connected with its deposition; that in a horizontal part is stratified in concentric layers. The upper portions will be perfectly sectile and form admirable crayons, that at the lower part will scratch glass; it decreases in density from the bottom; a portion of the sides partakes of both qualities. He suspected, that a large quantity was sold as black lead.

Mr. Williams remarked, that there were two kinds of peat, the one having a density due to impurities; this is useless for all purposes of metallurgy.—But for the purest carbon, the upper surface of the moss must be used, and an artificial density must be communicated to it; it is only in this manner that a dense and pure coke can be obtained. The peat having this artificial density is carbonized, by which all the volatile matter useless in combustion is driven off, ground, and then being mixed with a bituminous matter the operation of nature in the production of various species of coal may be closely imitated.—*Inst. Civ. Engineers.*

Jour. Arts & Science,

### *On the use of the Metal Palladium.*

This peculiar metal, discovered by the late Dr. Wollaston, in the year 1803, was, for some years only known to exist in the native Platina, of Colombia. In 1812\* it was noticed by Mr. P. N. Johnson, in the coin and small negotiable ingots of gold brought from the Brazils.

The rarity of the metal has hitherto prevented its general use, hence few of its valuable properties have been applied in the arts.

The development by the Imperial Brazilian Mining Association, of the gold region of the province of Minas Geraës, (which is peculiar for the existence of this metal in combination with the gold,) has of late years rendered its introduction more general in lieu of gold or platina, over which for many purposes it has its advantages, viz: it equally resists *sulphuretted hydrogen* and *mineral acids*.

It requires a much greater degree of heat for fusion than gold. Its specific

\* See the Philosophical Magazine, vol. xl, page 4.

gravity is only about half that of platinum, and as  $11\frac{1}{2}$  is to 19 in relation to gold, and therefore it is more economical in use.

Its price is not one-eighth of that of gold, and less than half of that of platinum, calculating equal bulk.

It may, without injuring its properties, be brought to almost any extent of hardness or softness.

Its chief uses at present are confined to dental surgery, in graduated scales for astronomical, nautical, and other instruments, in springs for various purposes, for lightning points, inoculating lancets, and ornamental works of different descriptions.

It is separated from the gold by solution from nitric acid, and from some other metals by addition of caustic ammonia and hydrochloric acid; which process was discovered by Mr. P. N. Johnson, in 1817, and is preferable, both in economy and purity, to the use of prussiate of mercury. Ibid.

*Description of a Machine for cutting the teeth of Bevel Wheels.* By MR. DAVIES.

In consequence of the importance of the subject, the attention of practical and scientific men has been for some time devoted to the inquiry, and, at the Liverpool meeting of the Association, Prof. Willis communicated the results of his investigations. The mechanical invention now explained, was to provide the means by which any form, when determined, could be accurately obtained, but applied more particularly to the formation of the teeth of bevelled wheels. In constructing this apparatus, Mr. Davies availed himself of the well-known planing machine, which provides the means of bringing any piece of work attached to its moving table, in contact with the cutting tool of the machine, the cuttings thus produced being in lines parallel with the bed. The arrangement for the machine provides for the wheel being caused to have a revolving movement either in a horizontal or a vertical plane, the combination of these two movements being similar to that of a universal joint. A lever or guide-rod is attached to the frame at one end, and at the other it is confined by a slit, which it fits exactly. The slit is formed in a vertical piece of metal which is attached to the movable table of the machine. Motion is given to this guide by means of a screw, when it describes the exact curve of the slit, and this movement is communicated to the bevelled wheel through the frame to which it is attached. As the part of this guide-rod which, by its traversing, influences the form, is much more distant from the centre of motion than the wheel, any error in the form of the slit will be diminished on the wheel in direct proportion to these differences. The only precautions requisite in using this machine are to insure that the centre of the cone, which would be formed by the extension of the bevelled wheel, is true with the centre of the bearings; and that the cutter be so placed, that in the traversing of the machine, the centre point will constantly approach the cutting point of the tool.

Athenæum.

*Anhydrous Protochloride of Tin.*

M. Capitaine gives the following as a simple and very economical method of preparing anhydrous protochloride of tin:—Heat the muriate of tin of commerce in a large Hessian crucible; it is not possible to perform the operation in a retort, as some authors advise, for the salt swells and passes over into the receiver without undergoing any alteration; when moderately heated



in the crucible it fuses, swells and yields the vapour of water and of hydrochloric acid; soon after this it undergoes igneous fusion, and when in quiet fusion it is to be poured into a smaller crucible. On cooling it becomes a brown mass, which is to be reduced to coarse powder and distilled in a coated glass retort. The first product is perfectly pure, the latter contains a little iron, which is to be separated by redistillation. The properties of this substance are that it is compact, nearly of a pure white colour, brittle, and has a vitreous fracture; when heated it fuses at about 482 deg. Fahr., boils, and volatilizes at a little below a red heat. It possesses a property which must always prevent the density of its vapour from being ascertained, which is that it is never completely volatilized without undergoing partial decomposition, the results of which are perchloride of tin, and yellow, earthy subchloride of tin, which remains in the distilling apparatus. When in a state of fusion it has a great tendency to penetrate the crucibles.

It dissolves in water without undergoing any immediate change; but the liquor remains clear only for a short time, and soon becoming turbid, it deposits oxychloride of tin. After a considerable time, in contact with the air, the oxychloride dissolves, and the liquor becomes clear and transparent.

Absolute alcohol dissolves it very readily, and more when hot than cold; by cooling the solution becomes syrupy. After some time the solution acquires a distinct odour of hydrochloric æther. When exposed to the air it long retains its property of precipitating the chloride of gold purple, and it does not become turbid. The protochloride of tin when anhydrous, is much less alterable by exposure to the air than when it contains water; indeed, unless it be hydrated it does not appear to absorb oxygen; after three weeks' exposure it remains completely soluble in water.

Mining Jour.

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*The Effects of Kyanising Wood.*

The effects of kyanising wood, with reference to living plants, has been noticed in different parts of the present volume. The result seems to be, that the Kyanising liquor is made so strong, that more corrosive sublimate is deposited, not only on the outer surface of the wood, but in its interior pores, than is wanted for entering into combination with the albumen. This superfluous quantity, then, in the case of hot-house rafters or sash-bars, being sublimated by the great heat of the house, escapes even through several coats of paint, contaminates the atmosphere, and injures vegetation for a time, till the source is exhausted. As the wood, when steeped in the Kyanising fluid, absorbs water in a considerable quantity, as well as mercury, it is easy to conceive that the heat of a hot-house will raise the temperature of the rafters and sash-bars, which are always in the hottest parts of the house, to such a degree as to expand the water into vapour, as well as the corrosive sublimate; and, thus pent up, the elastic fluids produced will readily burst through any layers of paint that could be laid on. A safe mode, when Kyanising for plant structures, would appear to be, to use the Kyanising liquor much weaker than is generally done; and, after the wood is removed from the tank, to dry it as thoroughly as if it had not been Kyanised, in order to get rid of the water absorbed during that process.

Gardener's Mag.

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*Peat and Charcoal.*

Mr. Farey alluded to the charcoal, or peat coke, which Mr. Oldham em-

ploys at the Bank of England; this is in thin cakes, and denser than the heaviest wood. Mr. Bramah remarked on the great value of compressed peat, could it be procured at a marketable price, on account of its superiority as a fuel for making large weldings.

The preceding minutes having been read, Mr. Parkes stated that the greater part of the charcoal used in Paris is from peat. The peat charcoal is preferred to the very best wood charcoal. There are two modes of making this charcoal: In a Swedish furnace, which is an oven made of lumps of peat, the pieces to be carbonised are placed in the interior, ignited, and smothered up in the usual manner. The other mode consists in getting peat as dense as coal, by allowing the small atoms to come within the natural force of cohesion. The peat for this purpose is dredged up from the bottom of streams, and laid up to dry, and formed into small bricks, which, on drying, contract very much. Compression will not do. In Holland they dig the turf and put it into running water. The water cannot be driven out by pressure. He had seen peat compressed with a force equal to that for pressing bowls for calenderers, but it was not near so dense as that formed by the natural means just alluded to.

Mr. Pellatt remarked, that the coking of coal does not deprive it of the sulphur. Washing the coke will remove much that remains; but even then it cannot be used for welding glass—nothing but the purest beech wood will serve for this. Charcoal will not answer, as it requires a flame. By welding, he meant the operation of putting a handle on a vessel. The glass being of a proper temperature, a union is formed, provided no sulphur be present.

Mr. Lowe remarked, it had been practically found that beech charcoal is valuable because of the quantity of carbon it contains. There is more pure carbon in a given weight of beech wood than of any other kind. Oak is the next best.

Inst. Civ. Eng.

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### *On a remarkable property of Electric Tension.*

M. C. Doppler, Professor of Mathematics, at Prague, has said that he has discovered that a feeble electric charge given to a bar of insulated metal causes it to contract; and, of course, if negatively electrized, the metal expands. The following is the method employed in the experiment:—

A thin copper tube, about three feet long, is properly placed in a delicate compound lever-apparatus, something similar to our lever-pyrometers, and properly insulated by glass stems. If now, a feeble electric tension be given to the tube, the index of the lever-apparatus immediately begins to move, indicating a *contraction* of the tube. By increasing the *tension*, the motion of the index is so swift that the eye cannot trace it; so that for high electric tensions a simple lever-apparatus answers better than the delicate compound one. When sparks are either intentionally taken from the tube, or that they are discharged spontaneously, the index rapidly recoils, indicating an *expansion* (prolongation) of the tube; which *contracts* again by an increase of electric tension. This property of electricity is said to have been discovered by a single pair of plates; and, as Poggendorff has justly said, “probably by an electric current,” which would render the circumstance still more curious, unless the current produced a depression of temperature in the tube.—*Poggendorff's Annalen*.

Sturgeon's Annals.

*Electric Deflagrations.*

Mr. Mason, of High Holborn, who is an exceedingly dexterous experimenter, has lately discovered a method of enhancing the beauty and splendour of charcoal deflagrations by voltaic electricity. He powders bichromate of potash and places the powder on the points of the charcoal, and when the latter has become red hot, the bichromate also enters into deflagration. The light produced is two-fold that given by the charcoal alone. The potash becomes decomposed and the liberated potassium scintillates in a very beautiful manner. We have seen Mr. Mason produce a beautiful effect with a battery of only thirty small jars.

Speaking of deflagrations, perhaps it may be interesting to some of our readers to know that the laminated metals, such as gold, silver, or copper leaf, &c., give a good effect when deflagrated on a strip of bright tin plate, which may be connected with one pole of the battery, whilst the metallic leaf, placed on a long copper wire in connexion with the other pole, is passed gently over its surface. Gold gives the feeblest light, copper next. The light from white Dutch metal is much more brilliant, and of a pale purple tinge. That from silver is exceedingly handsome, being a pale greenish yellow. We have, for many years, used zinc turnings for deflagrating at the lecture table. They burst into a complete blaze, and become converted into *philosophical wool*, which floats in the air for a long time afterwards. Ibid.

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*Case Hardening.*

At the British Institution of Civil Engineers the conversion of iron into steel was discussed, and it was stated that iron could be converted into steel by immersion in pure carbon, as in the Macintosh process, at the rate of  $\frac{1}{30}$ th of an inch per hour. Mr. Roberts stated that the success of case hardening depended on the gentleness of the heat. Great care must be taken not to overheat, and case hardening might take place to the depth of  $\frac{3}{8}$ ths of an inch in four or five hours. It was stated to be cyanogen united with iron which produces case hardening, but carbon which produces steel. An instance was mentioned by Mr. Carpmael in which animal charcoal was used for case hardening the interior, and vegetable charcoal for softening the exterior. Allusion was made to the fact, that the most perfect chill is obtained by the employment of moulds red hot. Inst. Civ. Eng.

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**Progress of Physical Science.**

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*On the Origin of the Vegetation of our Coal Fields and Wealdens.\** By  
J. T. BARBER BEAUMONT, ESQ., F. G. S.

A visit which I made during the last summer to the fossil trees recently discovered, apparently standing, as they grew, and rooted in an upper seam of coal in the line of the Bolton and Manchester Railway, has confirmed me in an opinion which I have always entertained, that the adopted theory of our coal-fields and wealdens being ancient deposits of trees in rivers and estuaries, is erroneous. The visible appearances to the contrary are now so many, and the anomalies they form to the doctrine taught are so puzzling

\* This paper was read at the meeting of the Geological Society, on the 20th day of November.



to young geologists, that I think it high time that this theory should be reconsidered. I think the facts prove, that in no instance is it likely that these formations arise from drifted trees sunk to the bottoms of mighty rivers and estuaries, but, on the contrary, that the coal vegetations grow where they are found, and that these places were the surfaces of small islands.

The adopted theory supposes that the coal-fields occupy the bed of "a mighty river or estuary," into which trees have been drifted and deposited; and that the alternating strata of coals and shale have resulted from successive deposits of plants, and of clay, sand, &c. Drifted trees in the deltas of some of the largest rivers are referred to as typical of these ancient masses of vegetation; and it is observed, that the coal formations and wealdens extending over Great Britain and the north of France do not much exceed the extent of the delta of the Mississippi or the Niger.

The first observation that strikes me on this theory seems fatal to its existence in toto. A mighty river or delta could only have existed in a mighty continent—a small continent would not do; there is no very mighty river or delta in Europe. Then the coal strata (near Newcastle) with the intermediate shale, are collectively 380 yards in thickness; the first deposit, therefore, must have been in a river or delta of that depth, which is about six times the mean depth of the German Ocean! What a continent there must have been to have produced a river or delta so wide and so deep! Such a continent we might reasonably expect would leave an abundance of fossils on its surface, as well as at the bottom of its great river; we ought to see fossilified timber trees, and bones of continental quadrupeds, for hundreds of leagues around; but, with a few exceptions of small extent, not a single timber tree, not a trace of a land animal is any where discovered. This absence of land fossils, I submit, is proof positive, geologically speaking, that there could have been no extensive continent within which the supposed river or delta was formed; but the proof goes further—all this land, for hundreds of leagues around the coal and the wealden vegetations, swarms with the remains of marine animals, in addition to marine plants, and nothing else—it is visibly ancient sea-bed.

But let us look at the composition of the actual coal-fields; not a large timber tree, or bone of a land quadruped is to be found in them; all that we see are masses of fern, rushes, canes, and the like, except in the upper strata, on which coniform trees are found, some of them in their growing position; but the principal beds extend for many miles, nearly of an uniform thickness, generally of only a few feet, and sometimes of only a few inches. It is truly stated, "The surface of these strata shows the bending branches, with their delicate apparatus of foliage, almost in the beauty and vigour of their primeval life." But if the strata were formed from drifted and sunk timber trees—and such, I submit, would not have failed to be supplied by an extensive continent—some massive trunks of trees would have occurred to disturb the uniformity of the thin coal seams. The superincumbent pressure did not flatten "the festoons of graceful foliage," or "bending branches," for they arise above the coal strata, and mingle with the shale over them. That pressure, therefore, could not have crushed the trunks and roots of timber trees to obliteration, had any existed, within the thickness of the coal seams; but the evenness of the coal strata is unbroken by any trunks and roots of timber trees. This, I think, completes the proofs that the coal seams could not have been composed of drifted trees, sunk in the depths of a mighty river. There is also natural evidence against the

vegetations being formed from sunken trees of any kind, in the vigour and freshness of their appearance; while in that state they would not have sunk at all, but have floated out to sea, as at the present day timber trees from America drift on our own coasts. To have sunk in the deep river they must have first rotted! But this could not have been, for the foliage is found with the "freshness and vigour of primeval life." Moreover, drifted trees are stopped in deltas from the shallowness of the water being insufficient to float them on; we know of no deposits of trees in deep water.

An eminent geologist, seemingly aware of the necessity of providing a continent for this great river or estuary, supposed that it might have been in the German Ocean; while another eminent professor, to whose labours the public are greatly indebted, finding that area too small, crosses to the other side, and speculates on the possibility of its having been in the Atlantic Ocean. But the speculations of there having been a mighty continent in an ocean far off to the east or to the west of our great river or estuary, is of no use whatever; to help the case, the continent must have actually encompassed the river or estuary; but all around the supposed river deposits, for hundreds of leagues, has been visibly sea-bed! There can be no river, mighty or minute, in a sea-bed. Further evidence and argument, in disproof of this theory, therefore, seems unnecessary.

In offering an opinion upon what really has been the origin of the coal-fields and wealdens, I shall be more diffident, and very brief. To my understanding, they appear to have been swampy islands. It is reasonable to believe, that on the first elevation of the rocks, while some stood high above the ocean, others would be nearly level with its surface, and that disjoined fragments and drifted clay, sand, and shells, would accumulate into islands; these would give rise to a profuse growth of marsh plants, which decaying and regenerating, others would accumulate, in the manner of peat-bogs, to various heights; and ferns, palms, calamites, and coniferous trees, in some positions, would acquire a gigantic growth. It seems not unreasonable also to conceive, that after the great bursting up of the crust of the earth, large cavernous hollows would be left, and that there would be many settlements in the broken crust before it finally subsided. An island, sunk beneath the ocean's surface by one of these settlements, would be covered with drifted clay, sand, and shells, and the tall cany trees upon it, if any, be broken down by the waves and detritus; new accumulations would again raise its surface above the ocean, somewhat like our coral islands; a fresh growth of plants would then take place, and then another settlement, and so on to the number of coal seams and shale that compose a formation. The coal seams and shale in some places, as near Newcastle, are unusually repeated, but repeated settlements of the surface would be no more than consistent with the extraordinary uplift they succeeded—in some cases also, depressions of the surface may have been followed by partial uplifts. Of such sighings of the earth we have examples even in our own time: the temple of Serapis is not one of the most modern.

The wealdens are still more easily recognised as ancient islands, raised after the coal-making heat and influence had gone by; we have only to suppose the coal and wealden herbaria to be as they most frequently present themselves to our eyes, the growth of the lands where we find them, instead of imagining them to be drifted deposits from an inconceivable continent to the bottom of a mighty but impossible river, and all the appearances about them will cease to perplex.

*On an anomalous Electric Condition of Iron.* By MARTYN I. ROBERTS, Esq.

It is now some months since, that while prosecuting a series of novel galvanic experiments, I discovered a singular anomaly in the electric condition of iron, which is, that although iron if associated with copper as a galvanic pair is highly positive to the copper, yet when associated with zinc, it is more highly negative to the zinc than copper would be under similar circumstances; or in other words, that although copper and iron form a galvanic combination, in which the iron is in the same relation to the copper that a zinc plate would be, yet that iron and zinc form a galvanic pair that has a greater power of generating electric action than a similar sized pair of copper and zinc. This singular phenomenon will, I believe, lead the way to some important discoveries; but not to occupy too much space in your valuable Journal, I will without further comment give extracts from my note-book of some experiments made by me on this subject.

Jan. 1st, 1839. A galvanic combination of iron and zinc was put in communication with two poles of a differential galvanometer; a like-sized combination (or gal. pair) of copper and zinc was connected with the other two poles of the diff. galvanometer: Deviation of needle in favour of the iron and zinc pair = 25 degrees.

Feb. 27, 1839. Experiments made on the comparative power of two galvanic batteries fitted up on Wollaston's plan (that is with the negative plate opposed to both surfaces of the zinc or positive plate.) The size of the plates was the same in both batteries, viz. zinc plate  $2\frac{1}{2}$  inch. by  $2\frac{1}{2}$  inch. The number of pairs in each battery was ten. The only difference between the two batteries was, that the negative plates in one were of copper and in the other of iron.

The exciting solution was dilute sulphuric acid, which was not renewed during the experiment, but the experiment was continued until the acid was exhausted. The power of each battery was applied to the decomposition of water, and the gas collected was the measure of the power.

## RESULTS.

*Battery of Copper and Zinc.*

|                                      |                |
|--------------------------------------|----------------|
| The first cubic inch of gas obtained | in 33 minutes. |
| Then one half cubic inch      "      | in 92 minutes. |

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Acid was now exhausted.  $1\frac{1}{2}$  cubic inch in 125 minutes.

*Battery of Iron and Zinc.*

|                           |                |
|---------------------------|----------------|
| First cubic inch obtained | in 7 minutes.  |
| Second      "      "      | in 9 minutes.  |
| Third      "      "       | in 26 minutes. |
| Fourth      "      "      | in 62 minutes. |

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Acid now exhausted. 4 cubic inch.      in 104 minutes.

Iron battery with a measured quantity of acid gave 4 cubic inches in 104 minutes.

Copper battery with a like quantity of acid gave only  $1\frac{1}{2}$  cubic inch in 125 minutes.

L. & E. Philos. Mag.



*Microscopic Geology.*

Professor Ehrenberg, already so justly famed for his microscopic discoveries in the animal and vegetable kingdoms, has recently added fresh lustre to his name by the pursuit of geological science. He has discovered that large masses of rock, and even whole strata of the earth are entirely composed of the remains of microscopic animals. The soft internal parts of these animalcules were, during life, covered with a tegument or case, composed of silica or flint; these earthly integuments have hitherto resisted decomposition, and now, in countless myriads, compose large portions of the globe. The cases are for the most part cylindrical, with transverse markings, and so hard, that the rocks composed of them are used as polishing stone. Of about eighty species of fossil infusoria which have been discovered in various strata, about one-half are identical with those which still exist in the waters; so that these classes of invisible creatures have a durability which has been denied to larger forms of life. Professor Ehrenberg has discovered that these microscopic animals exist at present in such abundance, under favourable circumstances, that there is no difficulty in accounting for the presence of the immense masses of their fossil remains. In the public garden at Berlin, workmen were employed for several days in removing wheelbarrows full of materials which consisted entirely of them. Ehrenberg has also succeeded in producing from masses of the living animals, tripoli and polishing slate, similar to the rocks from which he had originally obtained the remains; and he has added another to the numerous proofs of the correctness of the modern theories of geology, by showing that, while the microscopic contents of the more recent strata are all fresh-water infusoria, those of the chalk are animals which must, or at least could, have lived in the ocean. These discoveries were the result of great labour. Professor Ehrenberg had made a study of recent infusorial animalcules, during many years; and when his attention was drawn to the subject of fossil infusoria by M. Fisher, in 1836, he was able to recognise at once many species, which, in a living state, had been long familiar to him. Specimens of the rocks to which we have above alluded, and of the infusoria which compose them, are at present to be found in most of the mineralogical collections of Great Britain.—*The European*.

Mining Jour.

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*New Theory of the Tides.* By PROF. WHEWELL. *Cambridge Philosophical Society.*

At a meeting of this Society on the evening of Monday the 11th of November (Dr. Hodgson, the President, being in the chair), Mr. Whewell explained a new theory of the tides. The phænomena of the tides have hitherto been referred to the *equilibrium theory*, the elevation of the waters which occasions the tide being compared with the elevation which the moon would produce in the ocean if the earth and moon were both at rest. But the general motion of the waters of the ocean does not countenance this theory, or allow us to suppose that a fluid elevation resembling that of the equilibrium spheroid follows the moon from east to west; for the Pacific, the largest ocean, has no tide in its central parts; and at its eastern shore, near Cape Horn, the tide wave runs from west to east, although there is nothing to prevent its following its natural course.

The new theory which was offered was this:—The tide of each large

ocean may be considered as nearly independent of the tides of other waters. The central area of each ocean is occupied by a *lunar* wave, which oscillates, keeping time with the moon's returns, and having its motion kept up by the moon's attraction acting at each return. From the skirts of this oscillating central area, tides are carried on all sides by *free* waves, the velocity of which depends upon the depth and local circumstances of the sea; and thus the *litoral* tides may travel in any direction, while the *oceanic* tides near the centre of the oscillating area may be small or may vanish altogether.

This theory was confirmed by a reference to tide observations on the eastern and western sides of the Pacific, and by mathematical calculations tending to show that such a motion is mechanically possible. It was remarked that single observations can be of small use in deciding upon such a theory; and that it can be judged of only when we have observations numerous enough to enable us to draw the *systems* of cotidal lines which belong to the shores of the Pacific. With this view it is very desirable to obtain numerous and connected observations of the tides on the eastern shores of Australia, the Indian Archipelago, the Philippine Isles, the Loo Choo Isles, and Japan.

This theory to a certain extent coincides with the views respecting the tides published by Capt. Fitz Roy in his appendix to the voyages of the Adventure and Beagle.

L. & E. Philos. Mag.

### *The Bude Light.*

From the minutes of an examination of Goldworthy Gurney, and Dr. Faraday, before a committee of Parliament, on the Bude light which has been adopted as the mode of illumination in the House of Commons, it appears that this light is called the Bude light in reference to the residence of the former gentleman in Cornwall, where the experiments were made. His name was associated with the same light which we published an account of in 1823, and this was called the Bude light at the Trinity House by way of distinction.

The light is produced by throwing a stream of oxygen gas into the flame of a lamp, shaped like a small Argand. The interior of every flame being hollow, the vapour of the oil and the carburetted hydrogen is constantly liable to escape unburnt. The oxygen strikes the vacant carbon and vapour of oil as it is distilled, and produces an intense light.

Dr. Faraday testified that Gurney's lamp burns with remarkable steadiness for eight hours together, not requiring so much attention as an ordinary Argand lamp for the same time. There is no fear of danger from explosion, and the light can be managed by any person of common dexterity. The burners in the Bude light are rather more than a quarter of an inch in diameter and sixty burners consume about three pints of oil per hour. The lamps are so arranged that they can be raised and lowered to the amount of several feet, and the oxygen being brought to the light in small flexible tubes, the light may be moved about at the time it is burning.

Taking the price of manganese at 8 to 9 £ per ton, and estimating the usual wear and tear of apparatus and expense of fuel and attendance, the oxygen costs about 2d a cubic foot. There is an inexhaustible supply of manganese in Devonshire and Cornwall.

The lamp burned by Dr. Faraday gave a light of 20 Argands of  $\frac{3}{4}$  inch

in diameter, and in twelve hours burnt six and four-tenths pints of oil, and used sixty-four cubic feet of oxygen. This he considers as the best proportion, though there is such power over the lamp that it can be increased to almost any intensity.

Abstracted from a statement of the examination in the Nautical Magazine for November, 1839.

## Progress of Civil Engineering.

### *New Overshot Water Wheel.*

The great overshot wheel, erected by the Kilgetty Colliery Company, at Merrixton, near King's Moor, Pembrokeshire, was set to work on Saturday the 7th ult., in the presence of a large assembly of the ladies and gentlemen in the neighbourhood. This wheel, we believe, is the most powerful in the principality, being of 75 horse power; the diameter is forty-feet, and it is seven feet wide on the breast, and the buckets hold water more than one-third of the circumference. It is fixed in a manner that is quite novel in this country, the wheel being so closely shut in by finely-executed masonry, that the escape of water, without going to the buckets, is impossible. It works by eccentrics, giving a horizontal motion to the cranks, being the first application of this mechanical arrangement to such a purpose. It is adapted to work two pumps, giving twelve strokes a minute to each pump. The water is diverted from the stream about two miles from the wheel, and it is brought to it across the valley by an aqueduct, extending 300 feet in length, and from thirty to forty feet high. The wheel will supersede the use of steam power in the colliery, and it is contrived that, in time of drought, the water to be raised by the wheel will assist to drive it. The whole arrangements of the wheel are new applications of mechanism, and great improvements on plans hitherto in use. Considerable attention has been given to these works by parties who are not interested in them; and in the immediate neighbourhood, where so much enterprise at the present moment is in active operation in mineral undertakings, they well deserve the attention of all parties engaged in such enterprises. The works are close to the new road leading to Hobbs' Point, and may be conveniently inspected by parties travelling that way. The wheel and machinery were designed and executed by Mr. Thomas Dyson, of Downham, in Norfolk, where the wheel was made, and he has personally superintended the execution of the whole work. Although the wheel was made in order to drain the mine by pumps, it is understood the parties have since been advised to try instead the patent hydraulic belt, and intend to adopt it. A model was exhibited, and excited much surprise at its simplicity and its effective power to raise water on a small scale.

Lond. Mech. Mag.

### *Statistics of the Iron Trade. By HYDE CLARKE, Esq., C. E.*

In 1826 this country was visited by a French statistician, M. de Villegem, for the purpose of investigating the state of the iron manufacture, and he has given an estimate of the number of furnaces in that year, which seems generally accurate. The following is a table of the progress of each district, as far as it can be made out from the several authorities, although they are mixed up very confusedly. The returns of 1802, 1820, and 1827,



are from the Parliamentary returns; 1826, from the French estimate, and 1839 from the one given in the previous article.

|                                        | 1802.<br>Frn. | 1820.<br>Tons. | 1826.<br>Frn. | 1827.<br>Frn. Tons. | 1839.<br>Frn. Tons. |
|----------------------------------------|---------------|----------------|---------------|---------------------|---------------------|
| Scotland                               |               |                | 56            | 18 36,500           | 50 200,000          |
| Cumberland                             | } 28          | } 20,000       | } 84          | } 24 43,000         | } 32 86,000         |
| Northumberland, Lancaster, & Leicester |               |                |               |                     |                     |
| Yorkshire                              | } 28          | } 50,000       | } 14          | } 20,500            | } 19 40,000         |
| Derbyshire                             |               |                |               |                     |                     |
| North Wales                            | —†            | —              | 12            | 24,000              | 16 48,000           |
| Shropshire                             | } 42          | } 180,000      | } 31          | } 78,000            | } 40 150,000        |
| Stafford                               |               |                |               |                     |                     |
| Swansea District                       | —             |                | 78            | 95 216,000          | 125 400,000         |
| Gloicester                             | } 18          | } 150,000      | } 78          | } 90 272,000        | } 120 550,000       |
| Monmouth                               |               |                |               |                     |                     |
| Merthyr District                       | 52            |                |               |                     |                     |
|                                        | 227*          | 400,000        | 305†          | 284 690,000         | 417 1,512,000       |

The following is M. Virlet's estimate of the amount of iron annually produced in Europe in 1835, with an annexed column of corrections to the present time:—

|                          | M. Virlet.<br>Metrical quintals. | Estimate.<br>Tons. |
|--------------------------|----------------------------------|--------------------|
| England (1827)           | 7,968,000                        | 1,512,000          |
| France (1834)            | 2,200,000                        | 600,000            |
| Russia (1834)            | 1,150,000                        | 150,000            |
| Sweden and Norway (1825) | 1,000,000                        | 120,000            |
| Austria (1829)           | 850,000                          | 100,000            |
| Prussia                  | 800,000                          | 100,000            |
| Hartz Mountains          | 600,000                          | 70,000             |
| Belgium                  | 600,000                          | 80,000             |
| Elba and Italy           | 280,000                          | 28,000             |
| Sardinia                 | 225,000                          | 22,000             |
| Piedmont                 | [200,000]                        | —                  |
| Spain                    | 180,000                          | 18,000             |
| Norway                   | [150,000]                        | —                  |
| Denmark                  | 135,000                          | 13,000             |
| Bavaria                  | 130,000                          | 15,000             |
| Saxony                   | 80,000                           | 10,000             |
| Hanover                  | [10,000]                         | —                  |
| Poland                   | 75,000                           | 8,000              |
| Switzerland              | 30,000                           | 4,000              |
| Total                    | 13,433,000                       | 2,850,000          |
| Or about                 | 672,000 tons.                    |                    |

England produces about one-half the whole quantity, France about a fifth, Russia, Sweden, Austria, and Prussia, each about a twentieth. The total produce must be about three million tons.

\* Total in blast. † 250 in blast, produce 725,000 tons. ‡ With Merthyr.

The following, illustrative of the importance of the English iron trade, is a comparison of some of the European, English, and French iron districts. It may be premised, by the bye, that South Wales alone produces about as much as all France put together, and Staffordshire, Scotland, and Shropshire, each surpasses any other European country:—

| England.      |           | France.    |         | Europe. |           |
|---------------|-----------|------------|---------|---------|-----------|
|               | Tons.     |            | Tons.   |         | Tons.     |
| South Wales   | 550,000   | Champagne  | 124,000 | France  | 600,000   |
| Staffordshire | 400,000   | Jura       | 83,000  | Russia  | 150,000   |
| Scotland      | 200,000   | Ardennes   | 77,000  | Sweden  | 120,000   |
| Shropshire    | 150,000   | Nievre     | 64,000  | Austria | 100,000   |
| York, &c.     | 86,000    | North West | 35,000  | Prussia | 100,000   |
| Total         | 1,386,000 |            | 383,000 |         | 1,070,000 |

In concluding this subject it may be noted, that, for the service of the South Wales district alone, 300 miles of railway are constructed.

Mining Review.

*Difference of Longitude between Greenwich and New York.*

I have the satisfaction to inform you of a second instance of the successful transport of chronometers from London to New York, for the purpose of determining the longitude of these two cities. The first, as you will remember, took place in the months of July and August last. The result then obtained was compared with that given by M. Daussy, a distinguished French hydrographer, in the *Connaissance du Temps*. The difference of these results was 2.63 sec. This was satisfactory under the circumstances of a first attempt, made in the first trip across the Atlantic of the *British Queen*; still I felt the difference to be too great to be permitted to remain without an attempt to diminish it, or to ascertain which of the two was nearer the truth. On the very next voyage, therefore, of the same vessel, and under the same friendly auspices of Captain Roberts, and my friends in the United States, I sent a second set of four chronometers from London to New York. Their rates, &c., were ascertained precisely as those of the first set, and the whole experiment conducted in the same manner. This voyage of the *British Queen* was made, out and home, in the last and present months. The result, I have the pleasure to announce, is this time, almost exactly the same as that of M. Daussy's; so near, indeed, that I feel it to be a duty, and one of the most pleasing nature, to express thus publicly my great admiration of the accuracy of his statement:—

|                                                                                                                             | <i>h.</i> | <i>m.</i> | <i>sec.</i> |    |
|-----------------------------------------------------------------------------------------------------------------------------|-----------|-----------|-------------|----|
| By this second experiment the difference of longitude between the Observatory at Greenwich, and the City Hall, New York, is | 4         | 56        | 0.24        | W. |
| According to M. Daussy it is                                                                                                | 4         | 56        | 0.72        |    |
| Difference of the two observations                                                                                          | 0         | 0         | 0.48        |    |

The difference of the two observations does not therefore amount to half a second! For all the purposes of practical navigation it may be regarded as nothing.

This very minute variation in the estimates of the astronomical distance

of two meridians so widely separated as those of London and New York, will be very gratifying to every lover of practical science both in France and England, the more so, when it is considered that these estimates were made independently of each other, "by different observers, in different years, and in vessels propelled by different agents." Perhaps it ought not to be omitted, that in both the English experiments the instruments were sent out unattended by any *savant*, and brought home their own report.

During the first voyage there had been observed in all the chronometers, a difference between the mean travelling rate and the mean stationary rate, which had the remarkable character of being always on the same side, viz., the *losing* rates were always *increased*, and the *gaining* rates always *diminished*. The same curious fact again occurred in the second voyage. From this circumstance the longitude of New York was given by each chronometer scarcely enough to the westward in the outer-bound voyages, and rather too much so in the homeward ones.

The great rapidity and accuracy with which this important branch of nautical inquiry may be pursued over the whole surface of the globe, as the agency of steam shall be extended, is now, I think, demonstrated. The instances under consideration show that observations may be made connecting very distant countries, and their several results compared in a few weeks—a circumstance of great consequence—for with the diminution of duration in a voyage, proceeds, in a higher degree, the diminution of all the chances and causes of error in chronometrical experiments at sea. Within the space of ninety-nine days, we have seen the *British Queen* carry chronometers four times across the Atlantic, and give ample time during each other of her visits to New York for the necessary observations of rates, &c.

All objections founded on the idea that the motion of a steam-vessel would affect injuriously the more delicate movement of the chronometer, and taint the results, must now fall to the ground. In the two voyages out and home of the *British Queen*, no derangement occurred, and the determination of the longitude of the far-distant ports she sailed between, is, probably, settled for ever, within the fraction of a second of the truth.

I am, &c.,

ED. J. DENT.  
Athenæum.

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#### *Instrument for Ascertaining the Temperature of Water at Great Depths.*

In the extract which we published (p. 188) from Dr. Paterson's account of experiments on the temperature of Artesian Wells, an instrument is referred to as used by him in the course of his inquiry. At the request of several correspondents we take a further extract from the Doctor's interesting paper in the *Edinburgh New Philosophical Journal*, describing this instrument:—

"That objections might not be brought against this species of information, we used an instrument which has been long known for ascertaining the temperature of water at great depths. It consists of a glass-tube with brass ends which screw on; in each of these ends there is placed a valve, and both of the valves open upwards. It contains a thermometer, and is surrounded with a non-conductor; a string being attached to it, it is lowered down into the bored well. The water rushing up the bore, together with the instrument descending against it, causes both valves of the instrument to open, by which a free communication through the instrument by the valves is kept up, until it reaches the bottom of the perforation. The instrument is to be



allowed to remain there for a short time, and then withdrawn as quickly as possible. As soon as we begin to withdraw this instrument, the valves close, and consequently include a quantity of water from the lowest level, at which it has been.

“We have used the above described instrument on many different occasions, and in many different Artesian Wells, both those of recent and of several years’ formation, and on no occasion did we find the slightest difference of temperature between the water taken at the mouth of the bore and that brought up by the instrument.”

Ibid.

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*Railway Reports.*

The report presented to the proprietors of the London and Birmingham Railway, at the late half-yearly meeting, contains several statements of a highly satisfactory nature, to which we may here briefly advert, as all other companies must look with interest to the results afforded by this magnificent and ably-conducted undertaking. The directors remark that the receipts for passengers have been advancing steadily since the early part of the year; and it appears that the total number conveyed by the railway, for the six months, has been 267,527—the daily average for the whole length of the line, having been 857. The revenue for the half-year amounted to 270,814*l.*; the charges upon this sum, including interest on loans, and a reservation of 14,000*l.* for depreciation of stock, was 165,684*l.*, leaving an available balance of clear profit (including a surplus of 7083*l.* from the previous half-year), amounting to 112,213*l.* It was recommended by the directors that a dividend of 3*l.* 10*s.* per 100*l.* share (7 per cent. per annum), and amounting to 109,375*l.*, should be declared; and the report was, of course, carried unanimously, having evidently produced feelings of satisfaction in every proprietor present.

Mining Jour.

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*Improvement in Railway Carriages.*

On Wednesday, a lecture was delivered at the theatre of the Mechanics’ Institution, on a new description of railway carriages, invented by Mr. Coles of Charing-cross, and for which he has obtained a patent. The value of the invention was noticed in the *Mining Journal* at the time it was first made public, and by the working models exhibited, every statement formerly made was fully borne out. The improvement is, in the first place, by the addition of anti-friction wheels, which lessens the propelling power to one-eighth of that used by common carriages. Manual labour may be substituted for steam, and an increased speed is obtained; besides these advantages, the axles are formed on a safety principle, so that no irregularity of the railroad, or sudden curve, will cause the vehicle to run off, the axles working perpendicularly, horizontally, or obliquely, according to the position in which the vehicle may be accidentally thrown. Several eminent engineers were present, and gave their full approbation to the invention, and there is no doubt that in a short time the improved carriages will be used on the railroads.

Ibid.





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**JOURNAL**  
OF THE  
**FRANKLIN INSTITUTE**

OF THE  
**State of Pennsylvania,**  
AND  
**MECHANICS' REGISTER.**

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APRIL, 1840.

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**Practical and Theoretical Mechanics and Chemistry.**

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FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Remarks on the Combustion of Charcoal in close rooms, and its deleterious Effects.*

The frequent occurrence of fatal accidents, from the combustion of charcoal in close apartments, and the apparent prevalence of the idea, that a deleterious action on the animal system is peculiar to that kind of fuel, has induced me to offer, through the pages of the Journal, a few remarks intended to give a correct notion of the subject, in a popular form.

Every one who has given any attention to his own sensations of existence, is doubtless aware, that life is continued by the act of breathing. This operation is carried on by the muscular action of the chest; whereby a portion of air is drawn into the lungs, and again expelled, after imparting to the blood through the tissues of the lungs a portion of one of its constituents. The constituent which is the useful agent in this process, is termed by chemists oxygen, and sometimes vital air, it forms one fifth part of the atmosphere; the other four fifths being azote or nitrogen, with a small admixture of other gases. The oxygen alone, is necessary for respiration, the azote serving merely to dilute and diminish the activity of the vital air. By a process not yet clearly explained, oxygen imparts to the blood a renewed fitness for the maintainance of life, and is essentially necessary for that purpose; if an animal is deprived of oxygen for a short time it dies. Death by drowning is occasioned by the exclusion of oxygen from the lungs by the water, and may be produced by immersing the mouth and nostrils only; thus a man may be drowned in a single gallon of water.

This brief sketch of the process of respiration may serve to render intel-  
VOL. XXV.—No. 4, APRIL 1840.

ligible the cause of suffocation by the fumes of burning fuel. Whenever any combustible body is set on fire, the whole or a considerable portion of it unites with the oxygen of the atmosphere, and forms various gases differing according to the nature of the combustible, but all alike unfit for respiration; some of them, such as the gases produced by burning sulphur or phosphorus, being actively poisonous, will destroy life even when largely diluted; these give ample notice of their presence by their irritating action, and danger is avoided by timely escape. There is another large class of combustibles which produce a gas unfit for the support of life, but which not being acrid or poisonous does not give warning of danger. These have carbon as their base; they include wood, charcoal, anthracite, bituminous coal, coke, oil, illuminating gas, and in short all the materials in ordinary use for producing light and heat.

Every pound weight of the carbon contained in these substances, requires for its perfect combustion two pounds, or about 200 gallons, of oxygen, and produces about the same volume of carbonic acid gas, or fixed air. As above stated this gas is unfit for respiration, and if the mouth and nostrils of an animal be immersed in it for a short time death ensues. The same gas is found sometimes in coal pits, and is there known by the name of choke damp; it is also found at the bottom of deep wells, especially if they are dry; and in brewers' vats. Its presence may easily be detected by introducing a lighted candle into the suspected place; if the air is pure, the candle burns freely, but if largely contaminated with carbonic acid, it will be instantly extinguished. The gas may be displaced and absorbed by throwing in clear water, or what is still better, a dilute mixture of lime and water. As carbonic acid is heavier than atmospheric air of the same temperature, in the proportion of 3 to 2, it always, when cold, occupies the lower part of the apartment or vessel which contains it, and may be poured from one vessel to another like water. A curious example of this is shewn in the grotto Del Cano, in which a dog is speedily deprived of life, while a man, whose mouth is above the stratum of heavy gas, may enter with impunity. It may be asked, why if wood and bituminous coal produce carbonic acid, do we not hear of persons being injured by them, as well as by charcoal. The reason is simply this; the former contain in addition to carbon and earthy matter, several volatile ingredients, which are given out during combustion, and affect our senses so unpleasantly that we cannot endure the fumes long enough to be seriously injured, but are driven out before the oxygen of the apartment is exhausted.

In order to determine the best means of avoiding danger from burning carbon in an inhabited apartment, we must first take a hasty view of the circumstances attending the process. When the carbonic gas is first evolved, its temperature is raised by the heat of the fire considerably above that of the surrounding air; this increased temperature diminishes the density of the gas in the proportion of  $\frac{1}{300}$ th of its density at  $52^{\circ}$  Faht. for each degree of that scale. Thus, if the temperature of the air should be  $52^{\circ}$ , and that of the gas evolved  $552^{\circ}$ , the specific gravity of the latter would be only  $\frac{2}{3}$  that of the former, and it would tend to rise with a force varying with the height of the heated column. If, therefore, the combustion takes place in a close apartment, the carbonic gas would first rise to the ceiling, and remaining there until it was cooled nearly to the temperature of the air, it would afterwards sink to the floor and there remain. From this it will be perceived that no portion of such an apartment would be safe; the noxious influence invading successively all parts from the ceiling to the floor.



But if the fire be placed at the lower extremity of a vertical tube or channel leading out of the apartment, the rarification of the gas by heat causes it to expand within the tube, and the column within being lighter than the corresponding column without, the former is forced up by the colder air which rushes in to maintain the equilibrium. This is precisely the action of a common chimney, which may be termed a self-acting ventilator of the most perfect kind. Two circumstances are requisite to render the chimney effective, first the fire should be so nearly beneath it, that it may become heated; and secondly, there must be some other openings in the apartment for the admission of air; the latter are usually found in sufficient abundance in the crevices of the doors and windows, and the former is attained by making the fire in the fire-place, or in a stove connected with the chimney or pipe.

Unless both these conditions are satisfied, neither a fire nor a large light should be kept burning in the apartment.

The danger arising from carbonic gas is somewhat increased by its peculiar preliminary effects; when a person is in an apartment in which it is generated and gradually diffused, as from burning coals, or a light, the mingling of successive portions of it with the air produces a gentle lethargy, which is so far from being unpleasant, that the subject is inclined to resist any attempt to arouse him, and if not forcibly rescued will speedily sink into the repose of death. In cases of suspended animation from this cause, life may often be restored by timely application of cold water to the face, exposure to a current of fresh air, or fanning, with the occasional application of spirits of hartshorne or camphor to the nostrils, the camphor in particular I have seen used with excellent effect. C.

## Physical Science.

### *Association of American Geologists.*

At a meeting held at the rooms of the Franklin Institute in the City of Philadelphia, on the 2d of April, 1840, the following gentlemen were present, viz:

Edward Hitchcock, Amherst, Mass.; Lewis C. Beck, New Brunswick, N. J.; Henry D. Rogers, Philadelphia; Lardner Vanuxem, Bristol, Pa.; William W. Mather, Brooklyn, Ct.; Walter R. Johnson and Timothy A. Conrad, Philadelphia; Ebenezer Emmons and James Hall, Albany, N. Y.; Charles B. Trego, James C. Booth, M. H. Boyè, R. E. Rogers, and Alexander McKinley, Philadelphia; C. B. Haydon, Smithfield, Va.; Richard C. Taylor, Philadelphia; Douglass Houghton and Bela Hubbard, Detroit, Michigan.

Prof. HITCHCOCK was appointed Chairman, and

Prof. L. C. BECK, Secretary.

It was then unanimously resolved to organize an Association to be called "*The Association of American Geologists.*"

After the transaction of business relating to the election of additional members, the time and place for holding the next Annual meeting, &c., several communications were made to the Association and discussions had thereon. The following is a brief abstract of these proceedings.

*First Day.*—Specimens were laid on the table, of quartz, phosphate and carbonate of lime, having a fused appearance, occurring in St. Lawrence county, N. Y., and some views were offered concerning the causes which have given rise to it. Remarks having been made on this subject by several

other members, it was referred for a full report at the next meeting of the Association.

Specimens were next presented, of the sandstones of Massachusetts, exhibiting the fossil footmarks, so called, and some observations made in regard to them. This subject was of so much interest as to induce the Association to appoint a committee to visit the localities and to report their conclusions at the next meeting.

After this, followed a discussion on the subject of Diluvial Action, in which several members took part. Information was communicated concerning the diluvial grooves or scratches which are observed in the valleys of the Hudson, Ohio, and Mississippi,—the polished limestones of Western New York,—the erratic blocks found in New York, Pennsylvania, &c., and several points were suggested for future investigation.

*Second Day.*—The first business was a lecture on some parts of the Geology of the state of New Jersey. Upon this, remarks were offered by several members; after which there was presented to the Association,

An outline of the Geology of the state of Michigan. The remaining part of the day was spent in free conversation on various geological subjects.

*Third Day.*—The meeting was opened by some remarks on the apparent Stratification of Serpentine. A locality was referred to in the state of Pennsylvania where that rock exhibits the appearance of being regularly stratified. Several members presented facts concerning other localities bearing upon the question of the origin, whether strictly intrusive or metamorphic, of certain belts of Serpentine.

A statement was made in regard to the frequent occurrence of Fossil Infusoria in almost every town in New England in which primary rocks prevail. A member remarked that after the most diligent search he had been unable to detect them in the Cretaceous Group. After remarks by several other members, the conclusion was, that so far as Fossil Infusoria are known in this country, they are confined to the primary formations.

A notice was next presented of the occurrence of the Native Black Peroxide of copper on the shores of Lake Superior. This was followed by remarks upon the copper ores of New Jersey.

Some observations were then made regarding the Coal Fields of Pennsylvania, particularly with reference to certain changes in the chemical composition of the coal as we proceed from the east to the west. Statements corroborating the general correctness of the views presented, and extending the same to Ohio and Illinois, were made by other members.

Some suggestions were next offered concerning the fertilizing properties of Mica. These led to some remarks on the cause of the fertilizing powers of the green sand, the peroxide of iron, &c.—when it was

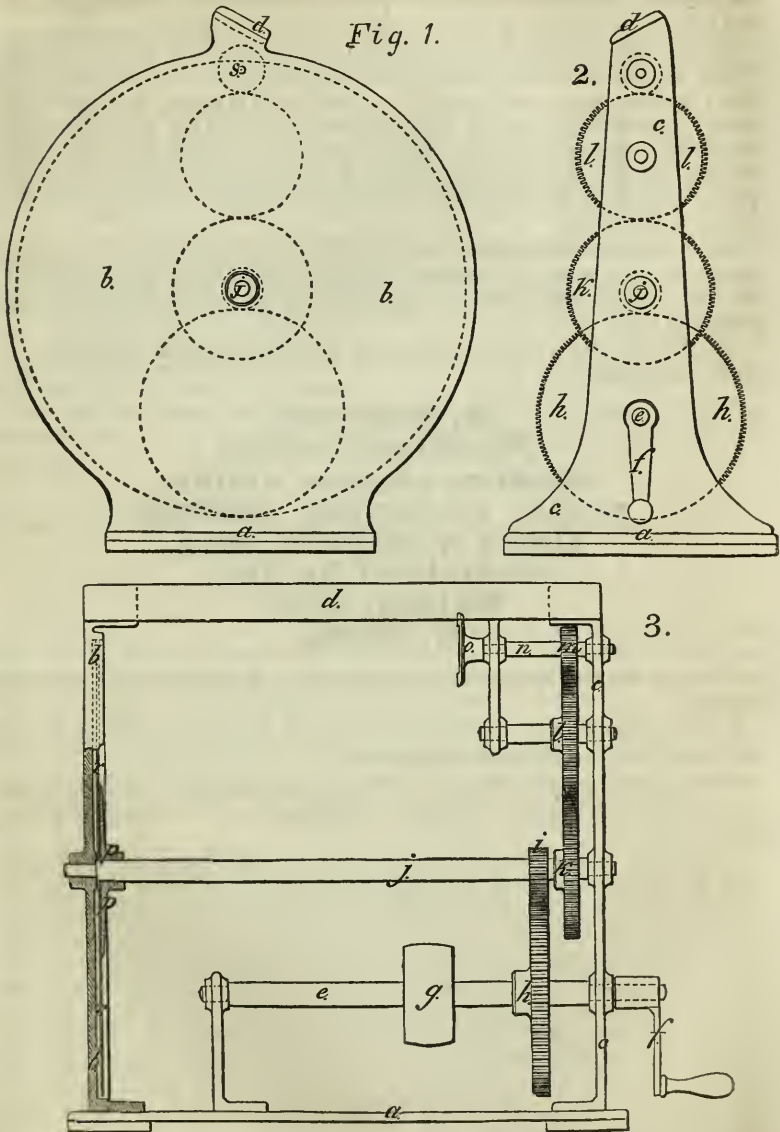
Resolved, that the subject of Mineral Manures be open for discussion at the next meeting; and that the members be requested to note all such facts as may contribute to its elucidation.

Professor Silliman was then unanimously elected chairman for the next meeting, and the present chairman was requested to open that meeting with an address.

The secretary was requested to prepare an abstract of the proceedings of this Session of the Association for publication in the American Journal of Science, and in the Journal of the Franklin Institute; when, after the usual resolution of thanks, the Association adjourned to meet in Philadelphia on the first Monday in April, 1841.

LEWIS C. BECK, *Secretary.*

*Description of an Optical Machine exhibited by MR. RD. ROBERTS, of Manchester, to the members of the British Association, at the meeting of that body in Dublin, in the year 1835.*



*a*, is the base plate, to which a plate *b*, and an upright arm *c*, connected with each other at the top by a cross-piece *d*, are bolted, forming together the frame of the machine.



*e* is a shaft, to which rotary motion may be given by the handle *f*, or by a strap from a steam engine, passing over a pulley *g*,—*h*, a toothed wheel gearing into *i*, a pinion on the shaft *j*,—*k*, a wheel on the same shaft gearing into *l*, an intermediate wheel that takes into the pinion *m*, on the spindle *n*,—to one end of which is secured a plate *o*, dovetailed on its face to receive and hold a card firmly, whilst the spindle revolves rapidly.

To one end of the shaft *j*, is attached a plate *p*, and to this is riveted a disc *r*, of thin sheet iron, which, when the machine is in motion revolves freely within a flanch on the plate *b*. (This flanch is merely to prevent accidents to persons who may be about the machine.) In the plate *b*, opposite the centre of the spindle *n*, is a circular aperture *s*, about  $\frac{3}{8}$  of an inch diameter, and opposite to this aperture there is an oblong hole in the disc *r*, about  $\frac{1}{2}$  an inch long in the direction of the disc's diameter, and  $\frac{1}{16}$  of an inch broad.

After the machine had been briefly explained to the section, it was placed in an anti-room where it remained during the meeting of the Association, that the members might have an opportunity of witnessing the phenomenon presented by it.

For this purpose a card 3 inches long by 2 inches broad, on the front of which was printed,

**R. Roberts's  
Machine, which  
renders objects visible  
while revolving 40,000  
times a minute, was  
examined by Dr.  
Dalton, Jan.  
9, 1835.**

was fixed to the face of the disc *o*, as the subject to be read while revolving rapidly.

NOTE—Several hundreds of these cards were distributed, having printed on the reverse the following explanation.

“When a firebrand is whirled in the dark, round a centre in a plane perpendicular to the eye of the spectator, it presents the appearance of a luminous circle.

“From this fact it has been inferred that the impression on the retina, made by the luminous body in its passage through every point of the circle, remains until the body has completed a revolution. How rapidly soever the firebrand may be made to revolve, the circle, and therefore, every part of it, will be distinctly visible: hence, a probability arises, that at the greatest attainable velocity, a perfect impression of the object in motion will still be produced on the optic nerve; providing that the time of viewing such object be limited to that which is required for passing through a small space—small, at least, with reference to the size of the revolving body—and also that no other object be presented on the field of vision before the former spectrum shall have vanished from the eye, unless in the case of the same object under similar circumstances.

“The former of these conditions is provided for in Machine No. 1, in which the eye-hole is made to travel through 180 feet between every two

inspections of the moving object, and which object is made to assume a different position at each successive inspection. The latter condition is included in Machine No. 2, the object is there presented to the eye in one position only.

RD. ROBERTS."

("Objects may be distinguished in the 150,000th of a second.")

On this card two machines are referred to, but as there was a great similarity between them, it has been thought unnecessary to describe more than Machine No. 2.

The machine was adapted for being turned either by hand or by other power, and in the absence of other power the parties wishing to witness the effect of the machine turned it for each other. Although in this manner few persons could give to the card a velocity of more than 6 or 8 thousand revolutions in a minute, yet as it was read with ease at these velocities, persons generally were disposed to be of opinion that there is no attainable velocity at which objects may not be distinguished.

Subsequently to the printing of the card, but before Mr. Roberts took his machine to Dublin, he had proved that the same card might be read whilst revolving 40,000 times a minute.

The time for each view of the card whilst turning at that velocity, does not exceed the 150,000th of a second.

This machine, therefore, shews that small print may be read on objects passing before the eye with the velocity of a ball when leaving the mouth of a cannon.

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*Notices of the Weather, and Meteorological Observations, made at Nashville, Tennessee.* By PROF. J. HAMILTON.

TO THE COMMITTEE OF THE FRANKLIN INSTITUTE ON METEOROLOGY.

Gentlemen,—I send you another quarterly sheet, in which may be found observations on the late equinox, similar to those of Dec. 21st, 1839. In connexion with them a few remarks upon the weather of the last three months, may not be unacceptable. The winter began earlier and continued with more uniformity than is usual in this region. Its average temperature was 38°.65. The deep snow of Dec. 30th and 31st, 1839, was succeeded on the 5th of Jan. by a thaw, with warm rains and a very dense fog, which continued several days. The temperature of the month was afterwards low until the 26th day. After four days of mild weather a change took place again, preceded by a thunder storm on the 29th, which was followed by a fall of snow to the depth of 2.5 inches, commencing on the 31st, at 4 P. M. The minimum temperature of Jan. was on the 2nd day when the Thermometer was as low as +5°, but rose to 42° at noon. The minimum on the 16th, 17th, 18th, and 19th days was respectively + 11 — + 11 — + 16 and + 6. Comparing these facts with observations in Philadelphia, you will perceive that the cold does not always advance upon us from the east. Maximum temperature of Jan. 65° on 29th—Minimum + 5 on 2nd—Range 60. Maximum of Barometer 30.04 on 25th—Minimum 29.18 on 29th—Range .86. Mean temperature of the month 34.85—Mean of Barometer 29.625—Rain 3.05 inches. The temperature of Feb. was generally mild. The second day was the coldest, when the minimum was + 4° and the mean of the day + 18°. A thunder storm occurred on the 9th and two others on the 27th—Maximum of thermometer 76 on the 19th, 27th, and 29th days—Minimum + 4° on the 2nd—Maximum of Barometer 30.03 on

the 15th—Minimum 29.12 on the 9th—monthly mean of thermometer 46.92—of Barometer 29.641. Amount of rain 4.87 inches. Peach tree in blossom on the 27th.

March came in mildly and gave fine weather, with the exception of a few days, until about the time of the Equinox. Thunder storms on the 2nd and 20th days, and another of great severity on the 23rd, during which four buildings in this city, without conductors, were struck by the lightning. Since that time the weather has been marked by great changes. On the 30th there were frequent storms of hail and rain with cold winds from W. and N. W. Much high wind during the month. Maximum of Thermometer 79 on the 18th—Minimum 23 on the 31st—Range 56—Maximum of Barometer 29.83 on the 21st—Minimum 29.10 on the 16th at 6 P. M.—Range .73. Mean temperature of March 54.25—Mean of Barometer 29.453—Rain 4.05 inches.

As you seem to have forgotten that in my observations the italic *c* denotes *cloudy*, and the roman *c* *clear*, it may not be improper to state that in the notes on the winter Solstice of 1839, the 24th day only presented a clear sky.

Very respectfully, yours, &c.,  
JAMES HAMILTON.

University of Nashville, April 1, 1840.

*Meteorological Observations, at the Vernal Equinox of 1840, made in conformity with the instructions of the South African Literary and Philosophical Institution, at the University of Nashville, Tennessee, in North Latitude, 36° 09' 33", W. Long. 86° 49' 03;" by JAMES HAMILTON, Prof. Math. and N. Philos.*

March 21, 1840.

| External Attach'd<br>Therm. Therm. Barom. |      |       |         |            |                                                                                  |
|-------------------------------------------|------|-------|---------|------------|----------------------------------------------------------------------------------|
|                                           |      |       |         | W.         |                                                                                  |
| 6 A. M.                                   | 34   | 49    | 29.82 c | N.E. by E. | 2 At 6h 50m rain and hail for 10m with gust of wind, which ceased with the rain. |
| 7                                         | 32.5 | 48.5  | 29.82 c | Do         | 1                                                                                |
| 8                                         | 32.5 | 48    | 29.83 c | Do         | 1 Again from 7h 20m to 7h 45m, during which                                      |
| 9                                         | 34   | 48    | 29.83 c | Do         | 1 Thermometer fell to 31°.                                                       |
| 10                                        | 37   | 47.5  | 29.85 c | Do         | 1 At 9h clouds begin to break in N. but were                                     |
|                                           |      |       |         | W.         | dense in S.                                                                      |
| 11                                        | 41   | 47.5  | 29.84 c | N.E.       | 1                                                                                |
|                                           |      |       |         | Do         | 1 Clouds gradually dispersing, and sun was seen                                  |
| 12                                        | 34   | 47.5  | 29.83 c | Do         | 1 through Transit at noon. Clear at 12½h,                                        |
| 1 P. M.                                   | 45   | 48    | 29.81 c | Do         | 1 except that a few cirrus clouds stretch                                        |
| 2                                         | 47.5 | 48    | 29.78 c | Do         | 1 from W. to E. forming an arch at N.                                            |
| 3                                         | 49   | 48.5  | 29.76 c | Do         | 1                                                                                |
| 4                                         | 49   | 48.5  | 29.75 c | Do         | 1                                                                                |
| 5                                         | 48.5 | 48.5  | 29.748c | Do         | 1                                                                                |
| 6                                         | 47   | 48.25 | 29.745c | Do         | 1 At 1 P. M. cirrus thinner and vertex of arch in                                |
|                                           |      |       |         | W.         | N.N.W.; continues to become clearer until                                        |
| 7                                         | 45   | 48    | 29.74 c | N.         | 1 at 8, clouds form in the west.                                                 |
| 8                                         | 42   | 48    | 29.74 c | Do         | 1 At 8h 40m wind 2.                                                              |
| 9                                         | 42   | 48    | 29.742c | N.W.       | 1 At 9h vertex of arch in N. W.                                                  |
| 10                                        | 40.5 | 48    | 29.76 c | Do         | 1 10h a thin stratum of clouds in W.                                             |
| 11                                        | 39   | 47.5  | 29.74 c | Do         | 1 10h 40m the same continues but is higher, and two others appear in the east.   |
|                                           |      |       |         | N.W.       |                                                                                  |
| 12                                        | 36   | 47    | 29.70 c | N.E.       | 1 Dew point at 3 P. M. 33°.                                                      |



*March 22.*

|         |      |      |         |              |   |                                                       |
|---------|------|------|---------|--------------|---|-------------------------------------------------------|
| 1 A. M. | 36   | 46.5 | 29.68 c | N.W.<br>E.   | 1 | Vapours collect and form the nebulus about<br>3 A. M. |
| 2       | 36   | 46   | 29.70 c | N.W.<br>N.E. | 1 |                                                       |
| 3       | 35   | 46   | 29.68 c | W.<br>N.E.   | 1 |                                                       |
| 4       | 34.5 | 46   | 29.67 c | Do           | 0 |                                                       |
| 5       | 34.5 | 45.5 | 29.67 c | Do           | 1 |                                                       |
| 6       | 35   | 45.5 | 29.68 c | Do           | 1 |                                                       |

Mean time found by Transit and kept by a superior clock. Fahrenheit's Thermometer—Barometer by Dolland—diameter of tube .4 inch, cup 2 inch.; height above ground 38 feet, and 128 feet above low water of the Cumberland river. External Thermometer, 35 feet above ground, north exposure.

On the day preceding the Equinox, double currents of wind were observed, the upper from the west and the under from the east. At sunrise the Thermometer was at 51° and the Barometer at 29.63. Clouds were gathering in the west and continued to become more and more dense until ten minutes past noon, at which time there was a storm of rain and hail, with thunder and lightning, that lasted until 1 P. M. When the storm began, the thermometer was at 45 and had fallen to 39 before its end. The double currents were perceptible, with the exception of a few hours, until the evening of the 23rd when a very violent thunder storm commenced at half-past 8 P. M. and lasted until 10 P. M., at which time the N. W. wind prevailed and blew very violently till sunset on the 25th. The clouds disappeared during the night of the 24th.

The double currents are marked in the table with the upper above a line and the under below. J. H.

## Civil Engineering.

*A Popular Exposition of the Incorrectness of the Tariffs of Toll in use on the Public Improvements of the United States. By CHARLES ELLET, Jr., Civil Engineer.*

[Concluded from Page 172.]

§ 4. *Of the most judicious charge on articles of heavy burden and small value.*

12. I conceive that it is essential to the fulfilment of the condition, that the tax levied on the trade of the line shall be reconcilable with principles of equity, that the charge at each point shall be proportional to the ability of the article to sustain it; and, it fortunately happens, that when the charges are regulated in the mode that will produce the maximum revenue, this condition will be fully satisfied.

We are to understand by the ability of a commodity to sustain a charge for carriage, the difference between the cost of production and the market value of the object. If the article be worth \$10 in market, and it costs \$6 to produce and prepare it for market, it will sustain any charge for transportation, including both freight and toll, not exceeding \$4. But its ability to sustain a charge *for toll only*, depends on the position in which it reaches

the line of the improvement. For, after deducting the cost of production from the market value, the residue may go to bear the whole cost of carriage; but we must still deduct from this residue the charge for freight, to obtain the sum which it will bear to be charged for toll.

If, for example, the above article reach the line at one hundred miles from the mart, and the freight be one cent per ton per mile, the charge for freight will be \$1, and this residue will be \$3. If it reach the line at two hundred miles, the charge for freight will be \$2, and this residue will be \$2. If it come on the work at three hundred miles, the charge for freight will be \$3, and the residue will be \$1; and if it reach it at four hundred miles, the freight will be \$4, and the residue will be nothing. I say, therefore, that to make the tax for toll proportional to the ability of the commodity, the charge levied by the State for its passage along

100 miles should be proportional to \$3,

200 miles should be proportional to \$2,

300 miles should be proportional to \$1,

and along four hundred miles it should be allowed to pass free. From which it appears, that *the greater the distance the commodity is carried, the less should be the toll levied upon it.* In short, I propose that the tax should be proportional to the ability of the trade to sustain the charge; and, by such a tariff, to supersede those now in use—by which the tax is *increased* in proportion as the ability of the trade to bear the tax is *diminished*.

13. Now, it may be demonstrated, that when the toll is assessed on this principle, both the tonnage and the revenue will be greater than if the most profitable uniform charge per mile that it is possible to levy were adopted.

But the method of determining this most productive charge, cannot be conveniently pointed out, with a demonstration of its correctness, in a mere popular discussion. I have, however, elsewhere considered the subject in some detail, and have shown that the toll on this division of the trade which will yield the greatest possible revenue, is about *three-eighths* of the charge which would exclude the article from market; or three-eighths the limit of the tax which it would bear.

In the above example, therefore, the charge at

|                                               |                      |
|-----------------------------------------------|----------------------|
| 100 miles, should be $\frac{3}{8}$ of \$3, or | \$1 12 $\frac{1}{2}$ |
| 200 miles, should be $\frac{3}{8}$ of \$2, or | 75                   |
| 300 miles, should be $\frac{3}{8}$ of \$1, or | 37 $\frac{1}{2}$     |
| 400 miles,                                    | 0 00                 |

The difference between these sums and those above given constitutes the profits of the proprietors.

It cannot be objected to this scale of charges, that it deprives the citizen on the line, near the mart, of any of the advantages of his position. The work, on the contrary, furnishes him with the means of transporting the products of his estate to a market for one-fourth, or one-fifth the sum he was compelled to expend before its construction. This is a positive advantage for which he is indebted to the commonwealth; and he has no right to complain, if the same commonwealth extend the benefits of the enterprise to more distant citizens. The avowed object of the improvement is to bring to market productions which could not otherwise reach it, and, generally, to reduce the tax on transportation. And if the objection, that the mode of charging here recommended may seem to disturb the relative advantages of position of the near and distant denizen, be a valid one, it is *a fortiori* a

conclusive argument against *all* improvement. A consequence of the construction of any canal or railroad, is to increase the value of estates to which it affords new facilities, and of course disturb the relation between the advantages possessed by such property and other estates in the commonwealth, on which it has no effect.

But such an objection, even if a legitimate one, cannot be applied to the scale here advised. It is not proposed to tax the distant man less for the transportation of his effects than the nearer one; on the contrary, he is charged more.\* The method merely proposes to make that portion of the tax which is to be considered as the profit of the State—that portion which is levied for revenue—proportional to the ability of the trade to pay it. And this is just.

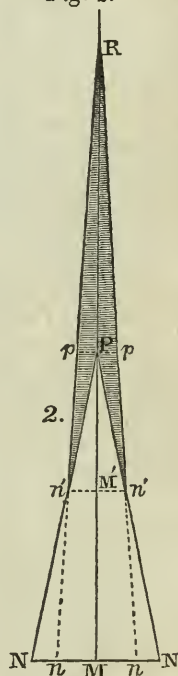
14. If, now, we represent by a proper scale, as in Fig. 2, the area of the country which, with the data of this example, would furnish the tonnage, in the hypothesis of an uniform charge of one cent for freight and one cent for toll, we shall have, as before stated, a triangular figure  $N P N$ , with a base,  $N N$ , of eighty miles, and height,  $M P$ , of two hundred miles.

But if the charges were adjusted with a view to the obtaining of the maximum revenue, the triangle would have a base,  $nn$ , of fifty miles, and a height,  $MR$ , of four hundred miles. In the one case the area of the country would be represented by the triangle  $N P N$ , and in the other by the triangle  $n R n$ .

15. But, instead of aiming to obtain the maximum revenue on all the trade which would reach the improvement from  $R$  to  $M$ , we may, by the system which it is intended to recommend, adopt in both instances an uniform charge for toll, as one cent per ton per mile, from  $M$  to  $M'$ —the point which corresponds with the intersection  $n'$  of the sides of the superior and inferior triangles—and confine the arrangement made with a view to the maximum revenue, to that portion of the country situated between  $M'$  and  $R$ .

The consequence of this arrangement would be to obtain the same tonnage and revenue from the country traversed by the portion  $M M'$  of the line, in both cases, since the tariff would in that distance be common; and at the same

Fig. 2.



\* In the example given in art. 12, as we have seen above, the toll

|                        |         |
|------------------------|---------|
| For 100 miles would be | \$1 12½ |
| 200   "   "            | 75      |
| 300   "   "            | 37½     |
| 400   "   "            | 00      |

But the *whole charge*, or freight and toll together,

|                        |         |
|------------------------|---------|
| For 100 miles would be | \$2 12½ |
| 200   "   "            | 2 75    |
| 300   "   "            | 3 37½   |
| 400   "   "            | 4 00    |

or, actually increasing in proportion to the distance, and at the rate of 6¼ mills per ton per mile.



time to increase the area of the country trading on the improvement, a quantity equal to the whole of the shaded space in the figure, and to increase the revenue a quantity equal to whatever would be due to this additional trade and the charge upon it, determined in accordance with the principles here laid down.

16. It will be perceived that the increase of tonnage and revenue which, in the preceding article, is shown to have place, will be obtained without any increase of toll on any part whatever of the trade. We have only to take the present tariff of New York or Pennsylvania, or any other state or company, and obtain these results *by a reduction of the charges*.

For, at the point P, which is supposed to be two hundred miles from M, we have seen that a toll of one cent per ton per mile would entirely exclude the trade. But if, instead of a charge of one cent per ton per mile, at that point, or \$2 for the entire toll from P to M, the article were taxed but seventy-five cents per ton, as is stated (in article 13) to be the proper toll under the circumstances, there would remain out of the \$2, which is the limit of the charge for toll it would bear at that position, a balance of \$1 25 to pay the expense of its transportation from *p* to P—a distance of twelve and a half miles on each side of the line. So that, by simply reducing the charge resulting from a tariff proportioned to the distance, we shall here obtain, instead of nothing, a revenue due to the tonnage that would be furnished by a district *p p*, twenty-five miles in breadth, at a charge of seventy-five cents per ton.

It is true that a much more important increase of revenue might be experienced by a modification of the uniform charge supposed to be levied from M to M', and a reduction from the new tariff beyond M'. For, even where we adopt the principle of fixing on a determinate toll per ton per mile for a certain distance, we should bear in mind that there is a certain uniform charge which will yield a higher result than any other. But, without any reference to this, or any of the other advantages which would be derived from a thorough and strict regard to the laws of trade in the establishment of the tariff, I have only sought to render clear the fact, that *by simple reductions of the charges on a portion of the trade on all our public works, the revenue and tonnage may be simultaneously increased, and the tax on the public may be rendered more equitable*.

17. The preceding conclusions are applicable only to the trade in heavy articles of small value. Equally salutary results might however be obtained by modifications of the charges on the other principal division of the commerce of the country—that which is rendered by its value an object for the competition of rival works. But the examination of the subject with reference to the latter division would, from its complication, be much less susceptible of receiving a popular form. This and other views of the subject, which have always to be considered in any attempt to establish a correct tariff, are examined in considerable detail in my "Essay on the Laws of Trade," where the methods to be adopted to obtain the greatest revenue which the work can possibly extract from the commerce of the country are fully exposed. It is not possible to repeat here, in the narrow space which can now be appropriated to the subject, even the most important of the principles to be regarded in the administration of our public works, which I have there attempted to develope. The glance which is here directed to the question is necessarily confined to a very few prominent points.

To establish a tariff of toll for all articles, on sound principles, requires a certain intimacy with the statistics of the line, and a proper acquaintance

the laws by which the tonnage and revenue are governed. This ledge cannot be obtained intuitively; and a correct tariff cannot be deduced, as those on all our improvements are, by the mere conjectures of the men to whose discretion such subjects are usually referred.

§ 5. *General Laws of Trade.*

There are some facts of a general character relating to this subject which are susceptible of a most rigorous demonstration, that may be here briefly repeated. It has already been shown that a great loss of trade revenue is sustained in the management of public works by the adoption of a uniform rate of assessment. In the examples adduced, this results in over-charges, which, under such regulations, invariably have place in every part of the line. It may be shown by a legitimate course of argument, however we depart from the charge which will yield the greatest revenue, there will be an increase or diminution of tonnage, and, of course, always a decrease of revenue. If the departure be an overcharge, *the tonnage will be reduced a quantity directly proportional to the value of the overcharge, and the revenue proportional to the square of that departure.*

Nothing can prove more conclusively the danger of submitting so important a subject as the preparation of a tariff, to the uncertain guide of conjecture.

For, if we err ten mills in the charge which we establish for any article, the loss will be one hundred times greater than if we err but one mill.

It is usual to assume that the charge for toll should be proportional to the distance the article is carried—that it should be greater for a great distance than a short one. But we have already seen that, on the contrary, in all cases, *the greater the distance the article is carried the less should be the toll exacted upon it.* (Art. 13.)

It is common to suppose either that the tariff of toll is independent of the cost of freight, or that the higher the expenses of carriage the greater should be the charge for toll. But, on the contrary, the fact is susceptible of a general and easy proof, that *the higher the charge for freight on the line, the lower must be the toll; and also that any increase of the cost of freight will at the same time diminish the toll or profit on the article, and increase the tax for its transportation.*

The charge for toll is also assumed, in the ordinary establishment of tolls, to be independent of the mode by which the trade approaches the work, and, for many articles, this is true; but, for others, it is an ascertained fact, susceptible of easy demonstration, that *if they are brought to the work by a common turnpike a higher toll should be charged for their passage on the turnpike than if the same articles reach the work by a railroad, and, à priori, than if brought by a canal.*

Where the object is to obtain the greatest possible revenue, it is a general law, susceptible of satisfactory proof, that *the charge for toll should not exceed half that charge which would exclude the trade from the line.* It may be shown, however, that, although a higher charge than this can never be advantageously adopted, it may frequently be reduced to *three-eighths* of the sum which would cause the exclusion of the trade, with a very beneficial effect on the tonnage, and without leading to any sacrifice on the score of revenue.

Another fact, which may be derived immediately from the preceding, is, that *at where the most judicious charge is levied, the tonnage of the line will be one-half of the tonnage which would be obtained if no toll at all were levied.*

24. The charge for toll has already been shown to depend in part on the price of freight; and it is an established law that if the cost of freight be increased or diminished by any modifications of the work, or the system of transportation adopted on it, *the toll must be increased just half as much as the freight is diminished, or diminished just half as much as the freight is increased.* And it is further susceptible of demonstration, that the increase of revenue which will follow a general reduction of the charge for freight *will at least be equal to the arithmetical mean between the values of the tonnage before and after the reduction multiplied by the amount that the freight is reduced.* In other words, if the trade of the line be one hundred thousand tons, and the freight be from any cause reduced \$1 per ton, and the tonnage thereby increased ten thousand tons, the revenue of the work will be increased more than \$105,000; and this result will have place simultaneously with a reduction of the whole tax on the trade to the amount of \$50,000, and the corresponding augmentation of the tonnage.

25. The fact is not usually recognised, that the toll, and tonnage, and revenue, are all more or less dependent on the length of the line of the improvement. It may, nevertheless, be easily proved by a general demonstration, that *the tonnage, the charge which may be levied per ton per mile, and consequently the revenue, will all receive an increase by a reduction of the length of the line of transportation.* So that if the toll be judiciously established on any given line, and any material change of location afterward be made, by which the distance, or cost of freight is diminished, there must be a certain increase of the charge for toll, from which an augmentation of revenue will necessarily result. *The value of this increase of revenue is equal to the whole annual tonnage of the line, multiplied by the actual cost of freight through the distance saved—and,* considering only the value of the trade, it is therefore worth, to reduce the length of the line, the capital of which the interest is equal to that sum.

26. In the arrangement of the charges in a tariff, there is no subject of greater importance, for some articles, than the positive, and for others, than the relative, value of the mart. From the positive value of the article, is determined the tax which one division of the trade can sustain; and from the relative value is in part deduced the proper toll on all commodities for which other works are competitors.

A permanent change of the relative standing of the mart, ought, therefore, to superinduce a modification of the toll. And it may be easily shown that if the relative value of the market—by which is intended its value compared with that of the rival mart—be increased any given sum, we shall find the corresponding increase of toll per mile proper to be made, *by dividing that increase by twice the length of the improvement in miles.* If, for instance, the value of Philadelphia as a mart for tobacco, compared with the value of New Orleans in reference to the same article, be, from any cause, increased \$4 per hogshead, and the distance from Philadelphia to Pittsburg be four hundred miles, then, I say, the toll on tobacco on the whole central line of the Pennsylvania improvement, should be increased a half-cent per ton per mile.

It is also easy to demonstrate that, at the same time, *the revenue will be augmented by any increase of the relative value of the market, an amount obtained by multiplying the original tonnage added to half the increase of tonnage consequent on the improvement of the market, by the increased value of the tonnage at the market.*

It is shown, in fact, that whatever circumstance occurs to increase the



value of the property sent along an improvement, to the holder of the property, will cause a certain increase of tonnage, of which the measure can be obtained, and a simultaneous augmentation of revenue equal to the whole increase of its value; and that *whatever unnecessary tax is levied on the trade, is at least so much deducted from the revenue of the improvement.* If, for instance, the engineer in making the location permit his line to be one mile longer than is essential, he will thereby cause to the State or Company an annual tax, or equivalent loss of dividend, equal to the whole annual expense of transporting the whole trade of the country through that mile. He incurs, at the same time, the responsibility of reducing the tonnage of the work, and of injuring, to a certain extent, both the country that supplies the trade, and the emporium which receives it.

If he embarrass the line by an unnecessary grade, or any other impediment which involves a similar increase of the charge for freight, he is responsible for the same result; and, before adopting such a measure, is bound to compare the value of the difficulties to be avoided, with that of these inevitable consequences to the future trade.

28. It is an error, and a very frequent one, to suppose that the toll is in any manner dependent on the cost of the work; or ought, under any circumstances, to be directly proportional to the value of the article. It is, however, not uncommon to assume, that it ought to bear some relation to the cost of construction; and there are tariffs of toll in the data for the calculation of which the value of the commodity is the principal, if not the only element. It is not a little singular that, after encountering an expense of hundreds of millions for our public works, the tariffs by which they are to be sustained should be entirely ruled by considerations which, however plausible in a superficial view, have no legitimate relation to the question.

For one division of the trade, it is not the positive value of the commodity, but the difference between the market value and the cost of production; and for the other, the difference between the value of the article at the mart of the improvement and at that of its rival, by which the toll is influenced. And this influence is only partial. The value of the article, taken in any sense, is only a part of the data by which the true charge must be determined.

29. It is by no means the intention here to attempt a general analysis of this most important subject. My object, as already announced, has been to show that, under certain circumstances, a marked increase of trade and revenue may be obtained on all our public works, by simply reducing the charges; and that such modifications of the tax levied on the community is rendered imperative by the first principles of equity. If I have succeeded in making this truth perfectly apparent, the design of these pages will be fully accomplished.

I scarce hope to have satisfied the reader in a discussion so brief and popular, that to enable a company to take the full advantage of its position, and obtain the highest degree of success of which their enterprise is susceptible, demands a careful and close investigation of the laws of trade in reference to every branch of the subject. To appreciate the importance of this course, requires that the mind should have investigated such questions sufficiently to estimate the consequences of its neglect. To know the value of establishing the most correct tariff, we need to know what we are likely to lose by the adoption of a conjectural or empirical one.

This subject, though usually taken under other auspices, is peculiarly a professional study. An intimate acquaintance with the principles which

govern the trade of an improvement, is a department of knowledge which is essential to the engineer in the location of his line, and the establishment of many of the plans of his work. His first duties, when properly discharged, compel him to become the most intimately acquainted with the productions and statistics of the country, and the information acquired in the accomplishment of these labours, ought to be turned to account in directing the future administration of the line.

The preparation of the tariff is, or ought to be, the peculiar province of the engineer. For, though there may be many considerations of policy, which should have a certain weight with those whose final action is requisite to carry his recommendations into effect—and which may frequently render it advisable to modify the charges which an *à priori* investigation may indicate to be proper, where the questions of trade and revenue only are under consideration,—still, it is not less important that the tariff should first be correct in itself, that some estimate may be made of the effect that will be felt when such political modifications come to be admitted. And, withal, it is difficult to conceive what motives of policy should induce any material departure from those limits which the administration of justice, the promotion of the trade, and the augmentation of the revenue simultaneously recommend.

*Philadelphia, November 6th, 1839.*

## Franklin Institute.

### COMMITTEE ON SCIENCE AND THE ARTS.

#### *Report on Mr. Edward Clark's process for making White Lead.*

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination the process for manufacturing White Lead, invented by Mr. Edward Clark, of New York; REPORT,

That it consists in the introduction of vapor of vinegar, carbonic acid and atmospheric air into chambers, which contain sheets of lead either rolled and placed on shelves, or open and hung on slats, the shelves or slats being supported by cleats attached to the posts forming the sides of the chambers, the vinegar is placed in a trough passing through the centre of the chambers and is heated by steam passing through its double bottom. The carbonic acid enters from the fire by which the steam is generated, and this gas, together with air, are forced into the chambers by bellows or from a gasometer. The main points of difference between the present and Richards' process, described in the Journal for 1839, lies in the introduction of steam by the latter into the chambers from above, and in the double walls of the chambers, which receiving steam maintain the inner chamber at a given temperature. Mr. Clarke's patent is dated Dec. 4th, 1828, reissued as amended in July 3d, 1832. Mr. Richards' was obtained a few years since. Between the present and the ordinary processes, the difference lies in the mode of elevating the temperature and generating the carbonic acid gas, which ordinarily are produced by the fermentation of vegetable matter (dung) which generates heat and carbonic acid, and vaporises the vinegar.

A process of a somewhat similar nature is pursued in the south of Germany, the lead sheets being hung on slats, which lie over troughs of about five feet in length, containing, on the bottom, vinegar mixed with wine-lees.

The troughs are piled up in a chamber which is heated by hot air or by steam. The vinegar is vaporised by the heat of the chamber and the carbonic acid arises from the fermentation of the lees. Great care is taken to exclude the atmosphere as far as possible, as it is found to injure the quality of the white lead, a point in which this process differs materially from those of Clark and Richards. The product is the finest quality of white lead in Europe, known as the Kremser white.

The introduction of carbonic acid, generated by the combustion of charcoal, for the purpose of assisting in the formation of white lead, has been practised many years in France in the new method of precipitating carbonate of lead; it has been farther employed in England, and in this country, in the manufacture of white lead. The novelty of Clark's process therefore consists in forcing atmospheric air into the lead chamber; Richards' in the introduction of steam in addition to the preceding; and both possess some claim to novelty in the peculiar arrangements of their apparatus.

The committee cannot draw conclusions relative to the economy of Clark's process nor to the quality of the material produced, as no theoretic grounds will warrant their so doing, but their views on this subject are given more at large in a report on Richards' method published in the July No. of the Journal of the Institute for 1839.

By order of the Committee,

WILLIAM HAMILTON, *Actuary.*

*Philadelphia, April 9th, 1840.*

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*Report on Mr. John P. Bakewell's Safety Valve.*

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a self acting Safety Valve, invented by Mr. John P. Bakewell, of Pittsburgh, Pa., REPORT:

That Mr. Bakewell represents his invention to consist in supporting the fulcrum of the lever of the common safety valve in such a manner that the more it may be loaded, for the purpose of keeping the valve closed, so much the more effective it will be in opening the valve, in case the boiler should become unduly heated.

To effect this object he makes use of a fusible alloy placed in a tube in the manner recommended some years back by Prof. A. D. Bache. (See Journal Franklin Inst., Vol. X, p. 223.)

The stem inserted in the fusible metal, supports the longer arm of a horizontal lever of the first order, the fulcrum of which is fixed in a standard rising from the valve case and extending some distance above the lever, for a purpose to be named presently. The shorter arm of this lever (which for the sake of convenient reference, we shall term the sustaining lever,) carries a short upright bar, on the upper end of which is the fulcrum of the safety valve lever; the latter being a lever of the second order loaded near its extremity in the usual manner.

While the fusible metal remains solid, it keeps the stem and sustaining lever steady, and the apparatus acts precisely like the common safety valve, the loaded lever resting parallel to, and a short distance above, the sustaining lever. But if the metal should be fused by overheating, the stem sinks into it; the short arm of the sustaining lever rises and elevates the fulcrum of the valve lever, the loaded end of the latter descends until the lever comes



in contact with a shoulder on the standard before mentioned. This shoulder now becomes the fulcrum of the valve lever, converting it into a lever of the first order, and the action of the weight with which it is loaded now tends to raise the valve with as much force as it previously exerted in keeping it down. The valve is by these means forced open, and, in the opinion of the inventor, will remove all danger of explosion by giving vent to the steam.

Without undertaking to discuss in this place the propriety of making an opening at such a juncture, the Committee take pleasure in expressing a favorable opinion of the contrivance proposed by Mr. Bakewell, for effecting that object. So far as appears, the arrangement is entirely novel, it is certainly very ingenious, and combines great simplicity with entire efficacy in opening the valve whenever the alloy is fused.

By order of the Committee.

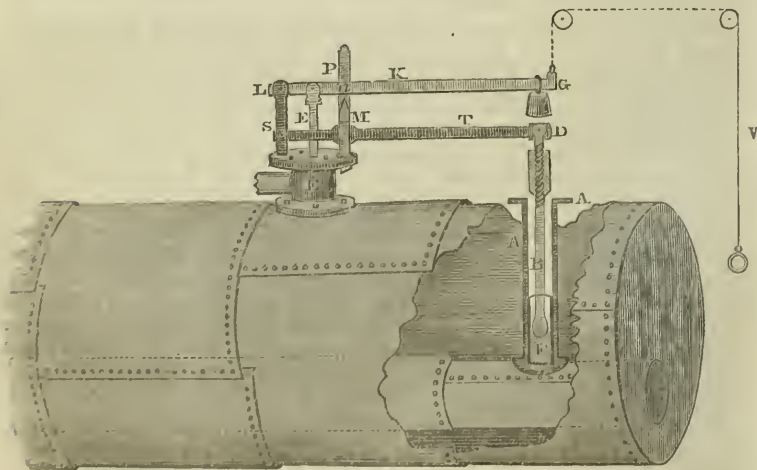
WILLIAM HAMILTON, *Actuary.*

Philadelphia, April 9th, 1840.

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*Description of the Self-acting Safety-valve, invented by MR. JOHN P. BAKEWELL, of Pittsburgh. Furnished by the inventor.*

The invention consists in a mode or method of fastening and securing the pivot end, or turning point, of the beam, or lever, of a common safety valve, in such a manner that the heavier the weight may be which is placed upon the opposite or long arm of the lever beam, for the purpose of keeping the valve closed—the more certain and effectual shall be the operation of the apparatus in opening the valve, whenever the boiler shall have been heated to such a degree of temperature as may be considered dangerous, or liable to become so; which may be done as follows, and is best explained on reference to the accompanying sketch or drawing of the same.



A, a metallic pipe or tube, which is to be placed within and securely fastened to the boiler with its lower end resting upon the flue, (or the bottom of the boiler if made without flues.)

B, a metallic rod or stem, constructed with an enlargement at one end, and connected, with a right and left screwed collar, to a piece made with a pivot hole at D.

E, the safety valve, made as usual, GKL lever beam.

F, a suitable quantity of the fusible metallic compound enclosed in a thin metallic cup, which is loosely connected at the top with the rod B, so that it can be taken out of the pipe A, if required, by raising the rod.

ST, a bent lever connected at L with the short end of the lever beam—turning in a slot at M, and connected with the upper part of B at D, and having an opening through which the stem of the safety valve passes freely without touching.

M, a standard or upright attached to the upper casing of the safety valve, and constructed with a slot to admit the free motion of ST, and with cheeks or guides above, which loosely clasp the lever beam; the bottom of which slot is filed to an edge, and is to be about one-half an inch below the bottom of the lever beam, as seen just below *n*.

It will be seen that the fusible metal will sustain the rod B and lever ST, as long as it shall remain unfused, and consequently serve as the support for the pivot end of the lever beam, GKL.

And that as soon as it becomes fused, it will allow of the descent of the rod B, and as soon as the lever beam touches the standard M at *n*, the action of the lever is reversed, and it must exert the same power to open the valve as was before exerted in holding it down.

To replace the apparatus, it will be requisite that whenever notice is given from the escape of steam that the boiler has become so much heated as to fuse the alloy—that the engineer should raise the lever beam by means of the usual lift line V, until it touches a bolt or pin P, which is passed through the cheeks of M, and at the same time withdrawing the stem from the melted alloy, and holding it there until the alloy is sufficiently cooled, either from the escape of steam or from cold water having been poured within the pipe A, so as to enable it to sustain the stem as at first.

The double right and left screwed collar is intended for the purpose of regulating the proper position of the lever ST, and connexion at L.

The claim as inserted in the patent is as follows, viz:

“I claim as my invention, the attachment of a rod or stem (B) to the end of the lever or beam of a safety valve, *in such a way*, that it shall be the fulcrum, pivot, or turning point of the beam, as long as the alloy remains unfused; and, I claim the placing of a standard or upright (M) between the safety-valve and the weighted end of the lever to which the beam shall shift its fulcrum or pivot whenever the alloy shall become fused or melted.”

The patent is dated December 21, 1839; application filed in September.

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## Mechanics' Register.

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LIST OF AMERICAN PATENTS WHICH ISSUED IN APRIL, 1839,  
*With Remarks and Exemplifications by the Editor.*

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1. For an improvement in *Church and other Bells, and in hanging the same*; Ebenezer Dewey, city of New York, April 10.

This bell is a cone, a section through the axis of which would present a right angle at its apex, its diameter at its base being equal to twice its height. “The diameter at the mouth of the bell is forty lines, and the

thickness of the lip is one line, and one third of a line in thickness at the top, and half a line in thickness at one third the distance from the base or mouth to the crown, and gradually diminishing in thickness from thence to the crown." These dimensions, it is said, may be changed. This bell is not intended to swing like the ordinary church bell, but it is attached to a cross timber which hangs on gudgeons at its ends to allow a free vibration and motion to the bell. The hammer strikes on its outside, its handle being affixed to a shaft which turns on gudgeons, and which stands parallel to, and above the timber by which the bell is suspended; this shaft has a pulley on its end to which the bell rope is attached, and in ringing, the hammer may be carried clear over from one side of the bell to the other. A spring on each side serves to hold the hammer clear of the bell after the stroke.

*Claim.*—"I claim the gradual diminution of the thickness of the sides of the conical bell from the lip at its base to its apex or crown, in the manner above described; and also the combination of the yoke and shaft containing the hammer handle and the spring, in the manner and for the purpose above described."

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2. For an improvement in the *Manufacture of White Lead*; Charles Button, of Great Britain, and Harrison G. Dyar, a citizen of the United States, April 10.

This invention is divided into three parts, consisting, first, of a method of purifying the gases and vapours arising from anthracite, stone or mineral coal, or from coke, so that the gases arising from such kinds of fuel may be used in the manufacture of white lead; secondly, in the use of basic nitrates of lead, for making carbonates of lead, and lastly, in manufacturing white lead from litharge, massicot, or protoxide of lead, by boiling nitrate of lead with either of those substances, and submitting such mixture while in a heated state, to the action of carbonic acid gas. The patentees describe the apparatus employed by them, but do not claim this as making any part of their invention. In the London Journal of Arts, vol. xiv, conjoined series, p. 383, there is an account of this patent, as obtained in England, accompanied by a plate showing the apparatus used.

The claims made are, "1st. The acting upon the vapours or gases, arising from the furnace used in the process of making white lead, in such a manner, (by the introduction of atmospheric air, and by washing, hereinbefore described,) as enables us to use that cheap kind of coal, called stone or mineral coal, in the said furnace, and to arrest the smoke and other impurities injurious to the colour or quality of white lead, so that we are enabled to use carbonic acid gas, obtained therefrom, in the process of manufacturing white lead.

"2d. In the manufacture of white lead from such compounds of nitric acid with oxide of lead, in which the quantity of oxide bears a greater ratio to the nitric acid combined therewith, than the oxide of lead bears to the nitric acid in the ordinary nitrate of lead of commerce; and which nitrates we call basic nitrates of lead.

"3d. Making white lead by boiling, as hereinbefore described, or otherwise acting upon the litharge, massicot or protoxide of lead, with either nitric acid or the common nitrate of lead of commerce; and while in a boiling state or otherwise, submitted to the action of, or brought minutely into contact with carbonic acid, in order to produce a pure carbonate of lead; or, as it is usually called, white lead; and in such manner, that the same nitric



acid or nitrate of lead may be used over and over again, many times, with fresh portions of litharge, as hereinbefore described.

"4th. and lastly. The process of further purifying and condensing the white lead obtained as aforesaid, by what we call inashing it, as hereinbefore described."

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3. For a *Washing Machine and Clothes Press*; Jonathan Read, city of New York, April 10.

It seems that there was novelty enough found in this machine to justify the grant of a patent; the whole affair, however, is obscurely described, and very imperfectly represented in the drawings; and after a sufficient examination of the whole matter, we do not think the time and space would be profitably employed in endeavouring to make its structure and operation known. The claim if given, would afford no information, excepting that a certain shaft, handles, wheels, straps and treadles, are to be used.

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4. For an improved *Garden Cultivator*; John Bush Smith, Princess Ann County, Virginia, April 10.

This machine is furnished with teeth, in the manner of other cultivators; its frame is to be supported on two wheels which may be varied in their distance apart by being made to slide on their axle, for the purpose of marking the ground of different widths. It has two handles by which it may be guided, and at its fore part a strip rises vertically, which is furnished with a slot, to enable the person managing the machine to take proper sight. The "claims made, are to the mode of directing the course of the machine by means of the sighting staff, and of adjusting the machine for different widths by shifting the wheels on the axle, as described." The improvements thus claimed appear to be of doubtful originality, as it is no new thing to fix a rod or stick upright in front of an agricultural implement to sight by; we have seen this done many years since, but whether it is a common device we do not know. The shifting of the wheels upon the axle to mark the widths of rows for planting is used in Rockwell's machine, patented on the 12th of March, and described in the last number of this Journal; we believe that this also was no new device.

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5. For *Preventing Injury from the Explosion of Steam Boilers*; Philip C. Friese, city of Baltimore, April 10.

The nature of this invention will be clearly understood by an examination of the claims, which are to "the application to steam boilers of a jacket, possessing in its construction the following three peculiarities.

"First. This jacket must envelope the steam boiler entirely, leaving throughout a certain intervening space between the jacket and the boiler.

"Second. This jacket must have a convenient number of holes in it; each hole to be fitted with pipes bent to whatever direction it may, in each case, be considered most harmless to lead the steam in the event of an explosion of the boiler.

"Third. This jacket must be able to resist, on every square inch of its inner surface, a pressure somewhat greater than the maximum that can be withstood on every square inch of the boiler."

This is a plan that has been often thought of, and often proposed, but we do not recollect that it has ever before been made the subject of a patent. The practical, if not theoretical, objections to it are such as will not admit of

its adoption. The cost of a boiler, and its weight, would be much more than doubled; it would be much less managable than the ordinary steam boiler, and would, from this cause, be more subjected to the influence of those circumstances which produce explosions. As respects "the maximum that can be withstood on every square inch of the boiler," we are not aware that the data are known by which the actual force can be measured to which a boiler is subjected in many cases of explosion; we have not yet determined what, under all circumstances, are the causes of explosions. This well intended effort to lessen the evils resulting therefrom will not, we apprehend, be adopted by engineers.

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6. For *Cutting Coats without back, side, or lapel seams*; William M. Wiswell, Portland, Maine, April 10.

To describe the plan intelligibly, which is the subject of this patent, would require the diagram given in the specification, and the references thereto. With respect to the utility and economy of the plan, we do not pretend to judge. We hope, for the sake of the patentee, that it may prove better than a similar one for cutting breeches, by which we were once, in our younger days, put "in durance vile," until they acquired, spontaneously, some slashes, affording the requisite liberty of motion.

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7. For a *Railway Cooking Stove*; Anson Atwood, city of Troy, New York, April 10.

Without the drawings, the peculiarities of this stove could not be made known. Railway stoves had been previously made, the object of them being to enlarge or contract the dimensions of the apparatus so as to adapt it to the purpose of cooking a larger or smaller quantity, as might be desired. The manner in which the present patentee had constructed his stove was deemed, in the office, to present sufficient novelty upon which to found the grant of a patent, but we are informed that upon a trial in court it has been pronounced to be an infringement upon a plan previously patented.

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8. For a *Corn Cultivator*; John B. Smith, Princess Ann county, Virginia, April 15.

The claim is to "the arrangement of the perforated beams, in combination with the shifting and reversible ploughs, for throwing the earth *from*, or *towards*, the rows of corn, regulated to any required width in the manner described." The two ploughs used with this cultivator are so constructed as that they may be placed nearer together, or further apart. When passing between rows of corn, or other plants, they are placed at such distance as that the horse shall draw them within the rows, and they are so sloped as to throw the earth outwards from them towards the corn. They are calculated also to run on the outsides of two rows, for which purpose they must be removed to a corresponding distance, and so turned as to throw the earth inwards, towards the plants. It is the particular construction by which this change is allowed that forms the subject of the foregoing claims.

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9. For improvements in *Steam Boilers*, and apparatus to prevent explosions thereof; Cadwallader Evans, Pittsburgh, Pennsylvania, April 15.

In the apparatus described in the specification of this patent, there is a very skilful arrangement and adaptation of the respective parts for the pur-

pose of preventing explosions. The fusible alloy is to be used, combined in a particular way with the common safety valve, and in such manner as to leave the valve free to act by the ordinary pressure of the steam; the alloy being intended to regulate the opening of the valve by the influence of temperature alone, irrespective of the pressure of the steam. The claim in this part is to the particular manner in which the combination is made between these parts.

To give notice of the descent of the water to a point below that of safety in either of the outside boilers in a series of boilers like those used on our western waters, a float is so used as to allow of the escape of steam, which is to sound a whistle on one side, and a horn on the other, which shall distinctly indicate the fact, and the boiler in which the water is deficient. The particular combination for effecting this, is claimed.

A water level of a peculiar construction is made so as to exhibit, in the cabin, the level of the water in the boiler, operating by its combination with the other parts of the apparatus in producing this result.

There is also claimed an apparatus for extinguishing the fire, which is made to operate by the fusible alloy apparatus; and likewise an apparatus for preventing the careening of a steam vessel at a pier, wharf, or bridge.

Without engravings, and the whole specification, we could not attempt to make known the nature of these various improvements; it is probable, however, that we shall obtain the means of so doing, and thus lay the whole matter before our readers.

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10. For an improvement in *Water Wheels*, and in the application of Water thereto; Eliza Martineau, administratrix of John Martineau, Elbridge, Onondaga county, New York, April 18.

Six, or any other convenient number of buckets, are to be fixed around a shaft, so as to revolve within a drum, or cylindrical case, which they are to fill, in width; the water is to be let in through a spout at the periphery of the wheel, and is to strike against the convex sides of the curved buckets, in order to give the water a tendency to continue near the periphery until it has passed round the circuit of the case; the escape for the water is at the centre of the wheel, which in this respect, and in the manner of letting the water on, resembles the wheel first patented by the late Joel Eastman, and subsequently with improvements, we believe, by Mr. Martineau.

The claim is to "the curved case, the inside of which is in the form of a scroll, in combination with the crooked, or curved, arms, as described."

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11. For a *Press for Hay, Cotton, &c.*; Chas. W. Hawkes, Brunswick, Cumberland county, Maine, April 18.

In this press the follower is to be brought down upon the hay, cotton, or other article contained in the pressing box, by means of a rack and pinion; to which, of course, no claim is made, the claims being confined to certain special arrangements intended to facilitate the operation; these consist in the mode of employing a lever to clear the follower from the interior of the box; a method of fastening the doors, &c.; these may be conveniences in this kind of press, but they do not require special description.

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12. For an improved *Grist Mill*; Oliver Wyman, East Cambridge, Middlesex county, Massachusetts, April 18.

The claims under this patent are to the "perforating the curb obliquely,



in the direction of the turning of the runner, for the purpose of admitting air for the cooling of the meal; and in combination therewith, the wings on the periphery of the runner for producing a draught through the oblique openings in the curb." There has been more than one patent granted for effecting the same object, but by arrangements sufficiently different to admit of the foregoing claim.

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13. For *Propelling Canal and other Boats*; William Leavenworth, city of New York, April 18.

The claim will give a pretty clear idea of the plan of propelling here proposed, which is "by means of an endless chain passing through the bottom of the boat, and resting on the bottom of the canal; its weight forming an anchorage against which any motive power may be exerted for the purpose of propelling the boat by drawing in the chain, in the manner described."

We are convinced that such a mode of propelling will never go into continued practical operation, the constant disturbance of the bottom of the canal would, in itself, be very objectionable; but the lifting and sustaining the weight of the chain would consume too large a portion of the propelling power to admit of its being employed to advantage.

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14. For an improved mode of *Moulding and Casting Water Wheels*; Stephen Parsons, Edgecombe, Lincoln county, Maine, April 18.

The water wheels to be moulded on the plan proposed in this patent, are the "curved vent, or reaction, water wheels." The particular procedure described, in moulding such wheels, forms the subject matter of the claim. A patent having the same object in view, was granted to Calvin Wing, of Maine, on the 22d of October, 1830, which was carried into successful operation. The modes, it seems, were sufficiently different to warrant the grant of the patent to the above named applicant; the matter is not of sufficient interest to require any extended remarks.

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15. For an improved *Plough*; John W. Jordan, Lexington, Rockbridge county, Virginia, April 19.

This patent is obtained for an improvement on the "inverting, hill-side, and horizontal plough," patented on the 28th of October, 1835. The improvements consist in certain devices for adjusting the height of the mould board, in combination with the method described for securing it in place.

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16. For improvements in *Bedsteads*; C. J. Fontaine, J. F. Adams, and G. F. Hillyer, city of New York, April 20.

The claim under this patent is to the dividing the head and foot rails crosswise, in the middle, and hinging them below the division, leaving a lap joint, for the sake of strength. These rails are also hinged to the posts at each end, on their upper sides, "so that when the bedstead is put up and in use, by lifting the end rails at the middle, [after removing the head board] where the joint is formed, the whole may be folded, or closed up, and moved from place to place, without being taken down, or the posts separated."

Where inventions very simple in their nature, appear as the joint production of several intellects, we have not unfrequently been at a loss to say in what way the suggestions made in perfecting the article could be divided into as many parts as there are persons concerned in it. They, however, appear as joint inventors, and we must believe them so to

be. As regards the foregoing invention, it may be useful where bedsteads require frequent removal of place, otherwise we should esteem it no improvement.

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17. For *Glasses and Frames for Spectacles*; Charles L. H. Jackson, city of New York, April 20.

The patentee states that the object of his invention is "to protect the eye from too strong a light as much as possible; and this I effect by leaving only a small portion of the surface of the glasses polished, and surround it with a ground space extending to the circumference, or outside rim, intending to obstruct the passage of the rays of light and soften their effects upon the eye, leaving that portion opposite to the pupil a small, clear, circular space." The bridge, and other parts, are to be so modified as to keep the spectacles steadily in place, as but a small portion of the glass is used for vision; the claims are to the preparing of the glasses, and of the frames, in the manner described.

The convenience, or inconvenience, resulting from the use of glasses thus prepared, and the effects they will produce upon the eye, must be determined by experience alone; our own impressions are that they will be found liable to objections which will prevent their general use.

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18. For an improvement in *Scales for Weighing*; Jonathan Ball, Buffalo, Erie county, New York, April 20.

These scales are of the kind in which the dish to receive the article to be weighed is above the beam. The beam is a graduated rod having sliding weights upon it, by which to ascertain the weight. The arrangement is undoubtedly new, and it is clearly described. The claims are to "the manner of constructing, and combining the balance frame, and movable graduated bars, as above described."

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19. For an improvement in the *Vice*; John Wetherill, Alleghany, Pennsylvania, April 22.

In bench, and other, vices, as ordinarily constructed, the bearing of the screw against the fore jaw, and of the screw box against the back, is constantly varying, as the vice is opened and closed, in such manner as to produce considerable friction; to obviate this, the patentee forms a projection on each side of the centre of the openings in the jaws, which projections are semi-cylindrical, and are received into corresponding hollows on the bearing part of the washer against which the head of the screw works, and also of the screw box; by which means the requisite horizontal vibration is allowed to equalize the bearing, and keep it constantly in the axis of the screw.

The claim is to "the pins, or projections to the cheeks or jaws of the vice, fitting into corresponding hollows on the face of the collar, or washer, of the screw pin; or of pins or projections upon collars fitting into hollows, in the cheeks, or jaws, in such a manner as to form a joint admitting of free motion for the purpose of preventing friction," &c.

A patent was obtained, some few years since, for forming the bearings of the screw, and of the screw box hemispherical, or rather portions of a sphere, received into corresponding concavities in the jaws of the vice; the effect of which is the same with the foregoing.

20. For a *Plough*; William Small, North Argyle, Washington county, New York, April 23.

The claim is to a mode of securing the lower piece of the land side by means of a hook in the fore end, and also to a mode of securing the hind end, in the particular manner described.

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21. For an improvement in *Fire Arms*; David Edwards, Morgan county, Ohio, April 25.

This patent adds another to the numerous family of many chambered fire arms, the novelties claimed relating principally to the manner of causing the many chambered cylinder to revolve, a matter which we shall not dwell upon, as not being likely to excite much interest; the claims would not make the proposed novelties clearly understood.

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22. For a *Horse Power*; William R. Arnold, Rochester, Munroe county, New York, April 26.

A patent was obtained by the above named gentleman, on the 7th of May, 1831, for a horse power, to which the present patent is intended to add certain improvements. These consist in the manner of constructing the cast iron treads upon which the horse is to operate; and in the manner in which these are geared. This arrangement is exhibited in several figures in the drawing, which would be requisite for the explanation.

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23. For a *Tailor's Measure*; Daniel Williams, city of New York, April 26.

The instrument used is the same in construction with that formerly patented by Mr. Williams, but he has added to it certain small pointed hooks which catch upon the coat of the person to whom the measuring instrument is to be applied, and hold it there during the operation; the claim is to these "grapple hooks."

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24. For an improvement in the manner of *Manufacturing the Leaves of Steel Springs for Carriages*; Micah Seabury, Waterville, Onecida county, New York, April 29.

The object in view is to give the proper taper and width, to the leaves of springs, by means of a rolling mill constructed for that purpose. The two rollers are made excentric, to the extent required for the taper of the springs to be rolled; and at the ends of these rollers there are grooves which constitute edging rollers, by which the plates are to be reduced to, and kept at, the proper width. The manner of forming them is fully described in the specification, and the claims made are to "the method described of giving to the metal, to be made into springs, the proper width, in combination with the method of giving the proper thickness and taper." There is but little of novelty in all this, the taper of springs having been given precisely in the manner set forth; but it is not known that they have been rolled to a width on the same rollers.

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25. For *Dressing Sawed Shingles*; Oliver N. May, Windsor, Broome county, New York, April 29.

The difference between this machine and some others for planing shingles, and other articles, is but small, and the claims are confined to those peculiarities by which it is supposed to be distinguished. There is not in it any striking feature requiring to be detailed.



## SPECIFICATIONS OF ENGLISH PATENTS.

*Specification of a patent granted to CHRISTOPHER NICKELS, of the county of Surrey, for his improvements in the mode of manufacturing fabrics from linen, woollen, silk, and other fibrous materials.*—[Sealed 15th March, 1839.]

The patentee says that the fibrous materials, cotton, wool, silk, flax, &c., having been made into the forms of fabrics by various means, such as felting, weaving, plaiting, knitting and lacing, and the same having been rendered waterproof by saturating them with a solution of Indian rubber, he does not claim any of these as forming a part of his invention; but that his improvement consists in placing a series of the threads, yarns, or strands of any of those fibrous materials, parallel, side by side, in contact in one continued plane, and causing them to adhere together by coating their surfaces with solutions of caoutchouc (Indian rubber,) shellac, or any other resinous matters, so as to produce a water-proof fabric.

The manner in which these threads, yarns, or strands of fibrous materials are to be spread out, so as to form a sheet, is not important; but in order to give the best information in his power, he describes one mode which he has found suited to the purpose.

He provides a large cylindrical drum of circumference and length equal to the dimensions of the sheet of fabric to be made; which drum being mounted upon an axle in suitable bearings, is enabled to revolve. A certain number of threads or yarns are then conducted from a series of bobbins or spools severally through the apertures of a reed, and their ends, in the first instance, made fast to the surface of the drum. The reed is affixed to a screw-box or nut, working upon a long horizontal screw-shaft, placed parallel to and in front of the drum. The drum is then put into rotary motion, which, by revolving, draws the threads or yarns from the bobbins or spools through the reed, and winds them round its periphery, in parallel position, side by side.

As the drum revolves, some gearing wheels connected to its axle give rotary motion also to the long screw-shaft, which causes the reed to travel along the screw by a slow progressive movement, and thereby to guide the threads or yarns upon the periphery of the drum in helical curves, until the nut with the reed has arrived at the end of the screw, when the threads or yarns will be found to have completely covered or clothed the entire surface of the cylindrical drum, in a similar way to the spreading of a warp in a warping-mill.

This laying of the fibrous materials in a smooth surface upon or round the periphery of the drum, being effected, a solution of Indian rubber or other suitable resinous material, is then applied and spread over the surface of the yarns or threads so extended upon the drum; and in order that the solution may be laid evenly upon the threads, a scraper formed by a straight-edge is brought near to the surface of the drum, and as the drum revolves, the superfluous adhesive material is scraped off.

The fabric so produced is then allowed to dry upon the drum,—that is, the adhesive material is suffered to become set, or nearly so; when, if the fabric is not sufficiently thick, another layer of the threads or yarns may be wound upon the former in the way and by the machinery above described,

and a further coating of the adhesive material may be put upon it in like manner; and when dry, the sheet must be removed from the surface of the drum, and will be found to be a water-proof fabric fit for use.

The patentee proposes, as a variety or modification of his invention, to cover the cylinder, in the first instance, with a woven fabric of cotton, wool, flax, or other material, and having wound upon this the threads or yarns in helical curves, side by side, as described, to coat the surface with the adhesive material, as before said, and then to place upon this, as an outer surface, a sheet of silk or any other fabric, and by that means to produce a water-proof fabric, having an ornamental or elegant face, for a superior sort of clothing, as for ladies' cloaks, scarfs, and other parts of garments.

Jour. Arts & Science.

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*Specification of a patent granted to JAMES DAVIS, Esq., of the county of Middlesex, for Improvements in the Manufacture of Soap.*—[Sealed April 23, 1839.]

In producing the various compositions hereinafter described, I manufacture soap in the same manner, in all respects, as that at present in use, up to the point when the soap is poured or cleansed into frames, or I take soap and remelt it, first, to produce a soap to be used in woollen manufactures and for washing every description of goods in salt or fresh water, and for general purposes at sea or on land, for every 126 lbs. of soap I take 56 lbs. of fuller's-earth slacked or dried, 56 lbs. of dried pipe-clay, and 112 lbs. of calcined soda, all reduced to a powder and sifted as fine as possible; I then pour the 126 lbs. of yellow or mottled soap in a liquid state from the boiler into the powder composed of the above mentioned materials, and mix the soap and the powder well together by stirring and grinding, then pour the compound-soap into frames to cool; great care should be observed in well combining the materials, and the mixing should be performed as quickly as possible before the soap cools.

Secondly, to obviate any possible objection, which might be suggested against the use of a soap or composition, partly prepared from fuller's-earth, for washing white linens, and other purposes, I produce a soap or composition for the washing of white linens, and for those purposes to which the first-described soap or composition might possibly be considered inapplicable by the several following methods. In producing a soap or composition for the washing of white linens in salt water, or such other general purposes at sea as are hereinbefore referred to, I entirely omit the use of fuller's-earth, and for every 120 lbs. of yellow or mottled soap, I take 112 lbs. of dried pipe-clay, and add 96 lbs. of calcined soda, all reduced to a powder, and sifted as fine as possible, into which the soap is poured, and the mixture is then blended and formed for use, as before described.

Thirdly, in producing a soap or composition for the washing of white linens in fresh water, and for such other general purposes, on shore, as are hereinbefore referred to, I also entirely omit the use of fuller's-earth, and for every 112 lbs. of soap, I take 28 lbs. of dried pipe-clay, and 36 lbs. of calcined soda, and all reduced to a powder, and sifted as fine as possible, into which the soap is poured, and the mixture is then blended and formed for use, as before described.

Fourthly, to produce a soap or composition for the toilet, to be used either in salt or fresh water. For every 112 lbs. of curd soap, I take 28 lbs. of

fuller's-earth, slacked or dried, 20 lbs. of calcined soda, and scented oil, according to fancy, the fuller's-earth and calcined soda being both reduced to a powder, and sifted as fine as possible, into which the soap is poured, and the mixture is blended and formed for use, as before described. In place of employing calcined soda, calcined pearlash may be used in precisely the same manner as that directed for the use of calcined soda; but in about one-half the quantity. I would however remark, that I prefer the use of calcined soda for all classes of soap, where it is to be employed by persons in contact with the skin to which pearlash is irritating.

Having thus described the nature of my invention, and the manner of performing the same, I do hereby declare, that what I claim is the mode of making soap by incorporating therewith calcined soda, fuller's-earth, or pipe-clay, or both fuller's-earth and pipe-clay, as above described. And I also claim the mode of making soap by incorporating therewith calcined pearlash, fuller's-earth, or pipe-clay, or both fuller's-earth and pipe-clay as above described.

Rep. Pat. Inven.

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*Specification of a patent granted to MOSES POOLE, of the county of Middlesex, for Improvements in the Manufacture of Soap, by the Application of Materials not hitherto used for that purpose.—[Sealed June 4, 1839.]*

The invention relates to the application of a product of fish obtained by means of digesting fish as early as possible after they are taken, without other preparation, in a Papin or such like digester. And in order to give the best information in my power, I will proceed to explain more fully the means pursued in order to perform the invention. But I would first remark, that I am aware that it is not new to employ fish or parts of fish in the making of soap, by submitting them with alkali to certain processes, but which having nothing to do with this invention, no description is required in this specification, and I have only mentioned the circumstance in order to disclaim all right and title to the employment of fish or parts thereof, in the making of soap when applied under other circumstances than according to this my specification. The apparatus and process of digesting bone in Papin's or such like digesters being well known, it will not require description here, and as a like process is to be performed on fish, by preference, in the state they are taken, and as soon after as convenient, little description will be required, the invention not relating to the process but to the application of the product in the making of soap. It may be desirable to state, that any description of fish may be used which can be obtained in large quantities, and at a cost which will allow of this application of the product obtained therefrom. And I may state that herrings and sprats are particularly applicable for the purpose. The fish are to be placed in the digester or boiler in the state they are taken, and by means of the digesting process with steam are to be wholly reduced to a jelly, which by preference should be immediately converted into soap either by itself or combined with fatty matters at present employed; but it is better to combine such product with an equal weight of tallow or other suitable fatty material for making soap, the product of fish being gradually incorporated with the tallow or fatty material in the boiler, and such product of fish alone or combined with other fatty matters are to be converted into soap by alkali, or by any of the ordinary means now practised in making soap from tallow or other fatty mat-



ters. The digesting process is performed with steam at 50 to 70lbs. on the square inch, the fish being covered with water at the commencement, and the process takes about five to seven hours.

Having thus described the nature of the invention, I would have it understood that what I claim is the mode of making soap by the application of a product of fish obtained by digesting as above described. Ibid.

*Specification of a patent granted to WILLIAM VICKERS, of the county of York, for an improvement in the Manufacture of Cast Steel.*—[Sealed June 25, 1839.]

To all to whom these presents shall come, &c. &c.—*Now know ye*, that in compliance with the said proviso, I, the said William Vickers, do hereby declare the nature of the said invention, to consist in the manufacture of cast steel at one process, out of borings or turning of wrought iron, (a cheap and refuse material not heretofore used for that purpose,) or out of small wrought iron scraps, such as old horse-shoe nails, broken bits of wire, and the like, by the introduction of oxide of manganese and carbon. And in further compliance with the said proviso, I, the said William Vickers, do hereby describe the manner in which the said invention is to be performed, by the following statement thereof (that is to say):—

In order to make cast steel on the said improved plan, the ordinary furnaces and crucibles, heats and moulds, may be used, (I prefer, however, a slightly increased temperature,) but instead of melting in these crucibles, broken pieces of bar-steel, commonly called blister-steel, as heretofore, from which to make the cast steel ingots, I melt the following ingredients together in the following proportions, that is to say: first, of ordinary wrought iron turnings or boring, or scraps, 100 lbs; second, of black oxide of manganese, two pounds; third, of best ground charcoal, three pounds. Or instead of the ground charcoal, cast-iron turnings, or borings, or other small particles of cast-iron may be used, in which case the following will be the proper proportions, that is to say: first, of ordinary wrought iron borings, or turnings, or scraps, 100 lbs; second, of black oxide of manganese, two pounds three ounces; third, of cast-iron turnings, or borings, or other such very small particles of cast-iron, twenty-eight pounds.

Now, whereas, it is evident that the foregoing proportions may be, in both cases, susceptible of some slight variations, dependent on the quality of the ingredients used; and it is only necessary further to observe, that if turnings are used, they should be pounded into small pieces before they are put into the crucible. But I claim as the invention aforesaid, the manufacturing of cast steel at one process from borings of wrought iron, or from turnings of wrought iron, or from wrought iron small scraps melted up with oxide of manganese, and also with carbon or with cast-iron turnings or borings, or other such very small particles of cast-iron, instead of the charcoal as hereinbefore mentioned. And such invention being to the best of my knowledge and belief entirely new, and never before used, within that part of her said Majesty's United Kingdom of Great Britain and Ireland, called England; Her said dominion of Wales, and town of Berwick-upon-Tweed, nor in any of Her said Majesty's colonies and plantations abroad; I do hereby declare this to be my specification of the same; and that I do verily believe this, my said specification, doth comply in all respects fully

and without reserve or disguise with the proviso, in the said hereinbefore in part recited letters patent contained; wherefore I do hereby claim to maintain exclusive right and privilege to the said invention.

Ibid.

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*Specification of a patent granted to SIR WILLIAM BURNETT, of the county of Middlesex, for his invention of improvements in preserving wood and other vegetable matters from decay.*—[Sealed July 26th, 1838.]

This invention consists in destroying the tendency of certain vegetable substances to decay, by submitting them to the action of chloride of zinc.

In preparing wood, canvas, cordage, sail-cloth, hemp, flax, and other vegetable matter, or articles made thereof, I provide a tank or other vessel of wood, or other suitable material; I then fill it about two-thirds full of chloride of zinc, dissolved in cold water, in the proportion of one pound of chloride of zinc to five gallons of water,—this I allow to remain for ten or twelve hours, when the solution is ready; I then place the material which is to be prepared in the solution, keeping it completely covered by the liquid.

If wood or timber is to be prepared, I allow it to remain in the solution from ten to twenty-one days, according to its size and thickness,—that is to say, if the timber be of the thickness of from eight to thirteen inches and upwards, I leave it immersed in the solution for twenty-one days; if from four to eight inches thick, for fourteen days; and if less than four inches thick, for ten days. When the wood or timber has been so immersed, I take it out and place it in a situation, sheltered from the weather, until it becomes perfectly dry.

In preparing canvas and cloth, I keep them in the solution for forty-eight hours, and then dry them under cover; and in this manner other vegetable materials of thin texture may be prepared.

In the preparation of rope or cordage, above the thickness of two inches, I steep the hemp or yarns, of which the same is to be formed, in the solution for forty-eight hours, and cordage or rope of two inches or less, I steep in the solution for seventy-two hours. In all cases, if tar is to be employed, the yarns forming the cordage should be placed in the solution for forty-eight hours, and allowed to dry before undergoing the tarring process.

In ship-building, and in building or repairing houses, besides preparing the timber to be used therein, as above described, I find it desirable to use a paint made by grinding impure oxide of zinc (*lapis calaminaris*) with oil or other suitable vehicle. This paint I recommend to be applied, at the time the materials are brought into contact, to the faying parts of all scarfs, and on the joists and faying parts wherever else two pieces of timber are brought into contact, and also on the under-sides of the flats of all magazine platforms, and all other platforms, below the orlops of ships of the line, and lower decks of frigates, and below the upper decks of sloops and smaller vessels.

In houses I recommend the paint, made as before stated, for the inside of skirting and wainscoating, of ground floors, and upon every part of the timber materials below the external surface of ground floors.

And I claim, as my improvements in preserving wood or other vegetable materials from decay, the use of the solution, above described, in the manner herein set forth.

Lond Jour. Arts & Sci.

*Specification of a patent granted to SAMUEL SANDERSON HALL, of the city of London, for improvements in preserving certain vegetable substances from decay, being a communication.*—[Sealed 3rd August, 1838.]

The claim set forth by the patentee, is for preserving wood and other vegetable substances from decay, by means of a solution of creosote, or essence of coal tar, dissolved in water. Ibid.

*Specification of a patent granted to JOSEPH PONS, of the county of Surrey, for an improved process of hardening wood and iron, and rendering wood repulsive of vermin and proof against dry-rot.*—[Sealed 22nd June, 1839.]

This improvement consists in the employment of a certain chemical solution in which the wood is to be steeped for a certain time, or the iron is to be dipped when in a heated state.

The chemical solution is described as formed by combining one hundred pounds of sulphate of iron, or of iron filings, with twenty-five pounds of nitric acid,—into which is to be introduced other solutions, viz: twenty-five pounds of alum, fourteen pounds of saltpetre, and five pounds of prussiate of potash. Each of these being separately dissolved in warm water, are to be mixed with the acid solution above described.

A wooden vat or tank is to be employed for holding this chemical solution, which should be kept at a temperature of about 5° Reaumur's thermometer. In this the wood to be hardened should remain immersed for a certain space of time, according to its substance. For pieces of wood from three to five inches in thickness, steeping for three or four days will be sufficient.

Hardening cast-iron, is effected by dipping it in the same chemical solution. The iron is to be heated to a blood-red heat, and then immersed in the liquor for a few minutes.

Wrought iron must be differently treated.—A paste is to be made by mixing five gallons of size with fourteen pounds of saltpetre and five pounds of prussiate of potash. With this paste the iron is to be coated in a cold state, and after having been heated to a blood-red, the iron is to be immersed in the chemical solution for about three minutes.

The patentee says he claims the above described processes for hardening wood and iron; but observes that "beneficial results may be obtained by dispeosing with the saltpetre and potash." Ibid.

*Specification of a patent granted to JOHN PETRIE, of Rochdale, in the county of Lancaster, mechanist and engineer, for his invention of certain improvements in steam engines.*—[Sealed 25th July, 1833.]

These improvements consist merely in heating the water before it is introduced into the boiler, by passing eduction steam from the working cylinder into a detached vessel, called a *caloric extractor*. Into this vessel the feed water is conducted by a cock, and the steam allowed to pass in at the same time by another aperture, so as to mix with the water; by which means the patentee proposes to raise its temperature to the boiling point before it is pumped into the boiler.

The claim of invention set out, is placing the caloric extractor between the working cylinder and the condenser of a low pressure engine, and be-



tween the working cylinder and the chimney in a high pressure engine, and regulating the supply of water to the caloric extractor, so that it shall never be introduced into the boiler at a lower temperature than 212° Fahrenheit.

Ibid.

*Specification of a patent granted to JAMES WALTON, of the county of York, for his invention of improvements in machinery for facilitating the operations of raising, dressing, and cropping the pile of woollen and some other fabrics.*—[Sealed 14th January, 1834.]

The subjects of this patent apply to the machine called a gig mill, in which a rotary barrel or barrels, partially covered with teasles, wire cards, or brushes, act against the surface of woollen cloths, for the purpose of drawing out the ends of the wool, called *raising the pile*. The same contrivances are also described as applicable to machines for cropping or shearing the pile.

As the cloth passes under or over the periphery of the gig barrels in an extended length, it is subject to wrinkle toward the middle of the barrel, and requires to be kept extended by the attendants continually pulling the lists outward. This the patentee proposes to remedy by changing the positions of the drawing and conducting rollers, so that the cloth may pass over or under the gig barrels, not exactly in the direction of a right angle to the axles of the barrel, but in a diagonal or oblique direction. This he effects by mounting the drawing and conducting rollers upon a movable frame, independent of that which supports the gig barrels, and giving to this frame a vibratory motion, so that the axles of the several rollers which conduct the cloth through, preserving their parallelism to each other, will be brought into such situations as will form angles of considerable obliquity to the axles of the gig barrels. By these means, as the frame and rollers vibrate, the cloth will be drawn first toward one side of the gig barrel and then toward the other side, and be thereby prevented from wrinkling in the middle.

The same contrivance will apply to such shearing machines as work with rotary cutters, and will assist in effecting a very desirable object, viz., cutting or cropping the pile in diagonal directions.

The second feature of the invention, is applying cushions with India rubber surfaces to parts of the periphery of the gig barrel, for the purpose of smoothing and polishing the face of the cloth.\*—This is not new.

The third improvement is the introduction of cushions, filled with water or air, as elastic beds, for pressing the cloth against the gig barrels, or against the cutters in the shearing frame.—This has also been done before, many years ago.

The fourth feature of invention, is the employment of double-threaded screws,—that is, screw shafts having a right-handed thread at one end, and a left-handed thread at the other, so that on being turned they may cause the distances of the rails of a stretching frame, to expand or contract.—This is likewise a very common and well known contrivance for the same purpose.

Ibid.

\* India rubber was applied exactly in the same way by Mr. G. D. Harris.—See his Patent of Jan. 15th, 1828, Vol. VI. p. 258, of Second Series of the London Journal of Arts and Sciences,

Progress of Practical and Theoretical Mechanics and Chemistry.

*On the Caoutchouc Manufacture.* By ANDREW URE, M. D., F. R. S., &c. &c.

This department of operative industry has, within a few years, acquired an importance equal to some of the older arts, and promises, ere long, to rival even the ancient textile fabrics in the variety of its designs and applications. The manufacture of caoutchouc has, at present, three principal branches—1. The condensation of the crude lumps or shreds of caoutchouc, as imported from South America, India, &c., into compact homogeneous blocks, and the cutting of these blocks into cakes or sheets for the stationer, surgeon, shoemaker, &c. 2. The filature of either the Indian rubber bottles, or the artificial sheet caoutchouc, into tapes and threads of any requisite length and fineness, which, being clothed with silk, cotton, linen, or woollen yarns, form the basis of elastic tissues of every kind. 3. The conversion of the refuse cuttings and coarser qualities of caoutchouc into a viscid varnish, which, being applied between two surfaces of cloth, constitutes the well-known double fabrics, impervious to water and air.

1. The caoutchouc, as imported in skinny shreds, fibrous balls, twisted concretions, cheese-like cakes, and irregular masses, is, more or less, impure, and sometimes fraudulently interstratified with earthy matter. It is cleansed by being cut into small pieces, and washed in warm water. It is now dried on iron trays, heated with steam, while being carefully stirred about to separate any remaining dirt, and is then passed through, between a pair of iron rolls, under a stream of water, whereby it gets a second washing, and becomes, at the same time, equalised, by the separate pieces being blended together. The shreds and cuttings thus laminated, if still foul or heterogeneous, are thrown back into a kind of hopper over the rolls, set one-sixteenth of an inch apart, and passed several times through between them. The above method of preparation is that practised by Messrs. Keene & Co., of Lambeth, in their excellent manufactory, under a patent granted in October, 1836, to Christopher Nickels, a partner in the firm.

In the great establishment of the Joint Stock Caoutchouc Company, at Tottenham, under the direction of Mr. Sievier, a gentleman distinguished no less by his genius and taste as a sculptor, than by his constructive talents, the preparatory rinsing and lamination are superseded by a process of washing practised in Mr. Nickels' second operation, commonly called the *grinding*, or, as it should more properly be styled, the *kneading*. The mill employed for agglutinating or incorporating the separate fragments and shreds of caoutchouc into a homogeneous elastic ball, is a cylindrical box or drum of cast iron, eight or nine inches in diameter, set on edge, and traversed in the line of its horizontal axis (also eight or nine inches long) by a shaft of wrought iron, furnished with three rows of projecting bars, or kneading arms, placed at angles of 120 deg. to each other. These act by rotation against five chisel-shaped teeth, which stand obliquely up from the front part of the bottom of the drum. The drum itself consists of two semi-cylinders; the under of which is made fast to a strong iron framing, and the upper is hinged to the under one behind, but bolted to it before, so as to form a cover or lid, which may be opened or laid back at pleasure, in order to examine the caoutchouc from time to time, and take it out when fully kneaded. In the centre of the lid a funnel is made fast, by which the cuttings and shreds of the Indian rubber are introduced, and a stream of water is made to trickle

in, for washing away the foul matter often imbedded in it. The power required to turn the axis of one of these mills, as the drums or boxes are called, may be judged of from the fact, that if it be only two inches in diameter, it is readily twisted asunder, and requires to be three inches to withstand every strain produced by the fixed teeth holding the caoutchouc against the revolving arms. Five pounds constitute a charge of the material.

One of the most remarkable phenomena of the kneading operation, is the prodigious heat disengaged in the alternate condensation and expansion of the caoutchouc. Though the water be cold as it trickles in, it soon becomes boiling hot, and emits copious vapours. When no water is admitted, the temperature rises much higher, so that the elastic lump, though a bad conductor of heat, cannot be safely touched with the hand. As we shall presently find that caoutchouc suffers no considerable or permanent diminution of its volume by the greatest pressure which can be applied, we must ascribe the heat evolved in the kneading process to the violent intestine movements excited throughout all the particles of the elastic mass.

During the steaming, much muddy water runs off through apertures in the bottom of the drum. In the course of half an hour's trituration, the various pieces become agglutinated into a soft, elastic, ovoid ball, of a reddish brown colour. This ball is now transferred into another similar iron drum, where it is exposed to the pricking and kneading action of three sets of chisel points, five in each set, that project from the revolving shaft at angles of 120 deg. to each other, and which encounter the resistance occasioned by five stationary chisel teeth, standing obliquely upwards from the bottom of the drum. Here the caoutchouc is kneaded dry along with a little quicklime. It soon gets very hot, discharges in steam through the punctures, the water and air which it had imbibed in the preceding washing operation, becomes, in consequence, more compact, and, in about an hour, assumes the dark brown colour of stationers' rubber. During all this time frequent explosions take place, from the expansion and sudden extrication of the imprisoned air and steam.

From the second set of drums the ball is transferred into a third set, whose revolving shaft, being furnished with both flat pressing bars, parallel, and sharp chisels, perpendicular to it, exercises the twofold operation of pricking and kneading the mass, so as to condense the caoutchouc into a homogeneous solid. Seven of these finished balls, weighing, as above stated, five pounds each, are then introduced into a much larger iron drum of similar construction, but of much greater strength, whose shaft is studded all round with a formidable array of blunt chisels. Here the separate balls become perfectly incorporated into one mass, free from honeycomb-cells or pores, and therefore fit for being squeezed into a rectangular or cylindrical form in a suitable cast iron mould, by the action of a screw press. When condensed to the utmost in this box, the lid is secured in its place by screw bolts, and the mould is set aside for several days. It is a curious fact that Mr. Sievier has tried to give this moulding force, by the hydraulic press, without effect, as the cake of caoutchouc, after being so condensed, resiles much more considerably than after the compressing action of the screw. The cake form generally preferred for the recomposed, ground, or milled caoutchouc, is a rectangular mass, about 18 inches long, 9 inches broad, and 5 inches thick.

This is sliced into cakes for the stationer, and into sheets for making tapes and threads of caoutchouc, by an ingenious self-acting machine, in which a straight steel blade, with its edge slanting downwards, is made to vibrate



most rapidly to and fro in a horizontal plane; while the cake of caoutchouc, clamped or embraced at each side between two strong iron bars, is slowly advanced against the blade by screw work, like that of the slide rest of a lathe. In cutting caoutchouc by knives of every form, it is essential that either the blade or the incision be constantly moistened with water; for otherwise the tool would immediately stick fast. Since the above straight vibrating knife slants obliquely downwards, the sheet which it cuts off spontaneously turns up over the blade in proportion as it is detached from the bottom mass of the cake. The thicker slices are afterwards cut by hand, with a wetted knife, into small parallelopipeds, for the stationer, the sections being guided rectangularly by saw lines in a wooden frame. The wholesale price of these is now reduced to 2s. per pound. Slices may be cut off to almost any desired degree of thinness, by means of an adjusting screw mechanism, that acts against a board which supports the bottom of the cake, and raises it by any aliquot part of an inch, the cutting blade being caused to vibrate always in the same horizontal plane. These thin slices constitute what is called sheet caoutchouc, and they serve perfectly for making tubes for pneumatic apparatus, and sheaths of every kind; since, if their two edges be cut obliquely with clean scissors, they may be made to coalesce, by great pressure, so intimately, that the line of junction cannot be discovered either by the eye, or by inflation of a bag or tube thus formed.

The mode of recomposing the cuttings, shreds, and coarse lumps of caoutchouc into a homogeneous elastic cake, specified by Mr. Nickels, for his patent, sealed October 24, 1836, is not essentially different from that above described. The cylinders of his mill are more capacious, are open at the sides like a cage, and do not require the washing apparatus, as the caoutchouc has been cleansed by previous lamination and rinsing. He completes the kneading operation, in this open cylinder, within the space of about two hours, and afterwards squeezes the large ball so formed into the cheese form, in a mould subjected to the action of a hydraulic press. As he succeeds perfectly in making compact cakes in this way, his caoutchouc must differ somewhat in its physical constitution from that recomposed by Mr. Sievier's process. He uses a press of the power of 70 tons; such pressure, however, must not be applied suddenly, but progressively, at intervals of two or three minutes between each stroke; and when the pressing is complete, he suffers the caoutchouc to remain under pressure till it is cold, when he thrusts it out of the mould entirely, or, placing his mould in the slide-rest mechanism, he gradually raises the caoutchouc out of it, while the vibrating knife cuts it into slices in the manner already described. The elegant machine by which these sheets are now so easily and accurately sliced, was, I believe, originally contrived and constructed by Mr. Beale, engineer, Church-lane, Whitechapel.

II. *Filature of Caoutchouc for making Elastic Fabrics.*—Messrs. Rattier and Guibal mounted in their factory at St. Denys, so long ago as the year 1826 or 1827, a machine for cutting a disc of caoutchouc into a continuous fillet spirally, from its circumference towards its centre. This flat disc was made by pressing the bottom part of a bottle of Indian rubber in an iron mould. I have described this machine under the article ELASTIC BANDS, in my Dictionary of Arts, &c. A machine on the same principle was made the subject of a patent by Mr. Joshua Proctor Westhead, of Manchester, in Feb. 16, 1836; and, being constructed with the well-known precision of Manchester workmanship, it has been found to act perfectly well in cutting

a disc of caoutchouc, from the circumference towards the centre spirally, into one continuous length of tape. For the service of this machine, the bottom of a bottle of Indian rubber of good quality being selected, is cut off and flattened by heat and pressure into a nearly round cake of uniform thickness. This cake is made fast at its centre by a screw nut and washer to the end of a horizontal shaft, which may be made to revolve with any desired velocity by means of appropriate pulleys and bands, at the same time that the edge of the disc of caoutchouc is acted on by a circular knife of cast steel, made to revolve 3000 times per minute, in a plane at right angles to that of the disc, and to advance upon its axis progressively, so as to pare off a continuous uniform tape or fillet from the circumference of the cake. During this cutting operation, the knife and caoutchouc are kept constantly moist with a slender stream of water. A succession of threads of any desired fineness are afterwards cut out of this fillet, by drawing it in a moist state through a guide slit, against the sharp edge of a revolving steel disc. This operation is dexterously performed by the hands of young girls. MM. Rattier and Guibal employed, at the abovementioned period, a mechanism consisting of a series of circular steel knives, fixed parallel to each other at minute distances, regulated by interposed washers upon a revolving shaft; which series of knives acted against another similar series, placed upon a parallel adjoining shaft, with the effect of cutting the tape throughout its length into eight or more threads at once. An improved modification of that apparatus is described and figured in the specification of Mr. Nickel's patent of October, 1836. He employs it for cutting into threads the tapes made from the recomposed caoutchouc.

The body of the bottle of Indian rubber, and in general any hollow cylinder of caoutchouc, is cut into tapes by being first forced upon a mandril of soft wood of such dimensions as to keep it equally distended. This mandril is then secured to the shaft of a lathe, which has one end formed into a fine-threaded screw, that works in a fixed nut, so as to traverse from right to left by its rotation. A circular disc of steel, kept moist, revolves upon a shaft parallel to the preceding, at such a distance from it as to cut through the caoutchouc, so that, by the traverse movement of the mandril shaft, the hollow cylinder is cut spirally into the continuous fillet of a breadth equal to the thickness of the side of the cylinder. Mr. Nickels has described two methods of forming hollow cylinders of recomposed caoutchouc for the purpose of being cut into fillets by such a machine.

It is probable that the threads formed from the best Indian rubber bottles, as imported from Para, are considerably stronger than those made from recomposed caoutchouc, and therefore much better adapted for making Mr. Sievier's beautiful patent elastic cordage. When, however, the kneading operation has been skilfully performed, I find that the threads of the *ground* caoutchouc, as it is incorrectly called by the workmen, answers well for every ordinary purpose of elastic fabrics, and are of course, greatly more economical, from the much lower price of the raw material.

Threads of caoutchouc are readily pieced by paring the broken ends obliquely with scissors, and then pressing them together with clean fingers, taking care to admit no grease or moisture within the junction line. These threads must be deprived of their elasticity before they can be made subservient to any torsile or textile manufacture. Each thread is *inelasticated* individually in the act of reeling, by the tenter boy or girl pressing it between his moist thumb and finger, so as to stretch it to at least eight times its natural length, while it is drawn rapidly through between them by the

rotation of the power-driven reel. This extension is accompanied with condensation of the caoutchouc, as shown in my former paper (see this Journal for last month,) and with very considerable disengagement of heat, as pointed out in Nicholson's Journal, upwards of 30 years ago, by Mr. Gough, the blind philosopher of Kendal. I attempted to stretch the thread, in the act of reeling, but found the sensation of heat too painful for my unseasoned fingers. The reels, after being completely filled with the thread, are laid aside for some days, more or fewer, according to the quality of the caoutchouc, the recomposed requiring a longer period than the bottle material. When thus rendered inelastic, it is wound off upon bobbins of various sizes, adapted to various sizes of brading, or other machines, where it is to be clothed with cotton or other yarn.

The thread of the Joint Stock Caoutchouc Company is numbered from 1 to 8. No. 1 is the finest, and has about 5000 yards in a pound weight; No. 4 has 2000 in a pound weight; and No. 8, 700, being a very powerful thread. The finest is used for the finer elastic tissues, as for ladies' silver and gold elastic bracelets and bands. The ropes made by Mr. Sievier with the strongest of the above threads, clothed with hemp, and worked in his gigantic braiding machine, possess, after they are re-elasticated by heat, an extraordinary strength and elasticity, and, from the nearly rectilinear direction of all the strands, can stand, it is said, double the strain of the best patent cordage of like diameter.

In treating of the manufacture of elastic fabrics, I have great pleasure in adverting to the ribbon looms at Holloway, which display to great advantage the mechanical genius of the patentee, Mr. Sievier. Their productive powers may be inferred from the following statement:—5000 yards of one inch braces are woven weekly in one 18 ribbon loom, whereby the female operative, who has nothing to do but to watch its automatic movements, earns 10s. a week; 3000 yards of two inch braces are woven upon a similar loom in the same time. But one of Mr. Sievier's most curious patent inventions, is that of producing, by the shrinking of the caoutchouc threads in the foundation or warp of the stuff, the appearance of raised figures, closely resembling coach lace, in the web. Thus, by a simple physical operation, there is produced, at an expense of one penny, an effect which could not be effected by mechanical means for less than one shilling.

III. *Of the Water-proof Double Fabrics.*—The parings, the waste of the kneading operations above described, and the coarsest qualities of imported caoutchouc, such as the inelastic lumps from Para, are worked up into varnish, wherewith two surfaces of cloth are cemented, so as to form a compound fabric, impervious to air and water. The caoutchouc is dissolved either in petroleum (coal tar) naphtha, or oil of turpentine, by being triturated with either of the solvents in a close cast iron pot, with a stirring apparatus, moved by mechanical power. The heat generated during the attrition of the caoutchouc, is sufficient to favour the solution, without the application of fuel in any way. These triturating pots have been called pug mills by the workmen, because they are furnished with obliquely pressing and revolving arms, but in other respects they differ in construction. They are four feet in diameter and depth, receive 13 cwt. at a time, have a vertical revolving shaft of wrought iron four inches in diameter, and make one turn in a second. Three days are required to complete the solution of one charge of the varnish materials. The proportion of the solvent oils varies with the object in view, being always much less in weight than the caoutchouc.

When the varnish is to be applied to very nice purposes, as bookbinding,



&c., it must be rubbed into a homogeneous smooth paste, by putting it in a hopper, and letting it fall between a couple of parallel iron rolls, set almost in contact.

The wooden framework of the gallery in which the waterproof cloth is manufactured, should be at least 50 yards long, to give ample room for extending, airing, and drying the pieces; it should be two yards wide, and not less than five high. It is formed of upright standards of wood, bound with three or four horizontal rails at the sides and the ends. At the end of the galley, where the varnish is applied, the web which is to be smeared must be wound upon a beam, resembling in size and situation the cloth beam of the weaver's loom. The piece is thence drawn up and stretched in a horizontal direction over a bar, like the breast beam of a loom, whence it is extended in a somewhat slanting direction downwards, and passed over the edge of a horizontal bar. Above this bar, and parallel to it, a steel-armed edge of wood is adjusted, so closely as to leave but a narrow slit for the passage of the varnish and the cloth. This horizontal slit may be widened or narrowed at pleasure by thumb screws, which lower or raise the movable upper board. The caoutchouc paste being plastered thickly with a long spatula of wood upon the down-sloped part of the web, which lies between the breast beam and the above described slit; the cloth is then drawn through the slit by means of cords in a horizontal direction along the lowest rails of the galley, whereby it gets uniformly besmeared. As soon as the whole web, consisting of about 40 yards, is thus coated with the viscid varnish, it is extended horizontally upon rollers, in the upper part of the gallery, and left for a day or two to dry. A second and third coat are then applied in succession. Two such webs, or pieces, are next cemented face to face, by passing them, at the instant of their being brought into contact, through between a pair of wooden rollers, care being taken by the operator to prevent the formation of any creases, or twisting of the twofold web. The under of the two pieces being intended for the lining, should be a couple of inches broader than the upper one, to ensure the uniform covering of the latter, which is destined to form the outside of the garment. The double cloth is finally suspended in a well ventilated stove room, till it becomes dry, and nearly free from smell. The parings cut from the broader edges of the under piece, are reserved for cementing the seams of cloaks and other articles of dress. The tape-like shreds of the double cloth are in great request among gardeners, for nailing up the twigs of wall shrubs.

Mr. Walton, of Sowerby-bridge, has recently substituted sheet Indian rubber for leather, in the construction of fillet cards for the cotton and tow manufactures. The superior elasticity of this article is said to prove advantageous in several respects.

*Jour. Arts & Science.*

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*On the mode of Producing Fac-simile copies of Medals, &c., by the agency of Voltaic Electricity.*

Sir,—You request a condensed account of my voltaic process of working in copper. I shall endeavour to give you one, premising, I shall divest it as much as possible of electro-chemical detail, that it may be rendered quite intelligible to those unacquainted with that science.

It has been long known that one metal will precipitate another from its solution. As one instance, if we take a solution of sulphate of copper, the blue vitriol of commerce, and dip the blade of a penknife in it, in a few seconds it becomes coated with pure metallic copper. We have here an

instance of simple electro-chemical action, and I may say, the type of all the experiments I have lately published on the subject. Subsequently, it has been found that copper itself possessed this quality, by acting on *its own* solutions, and to a much greater extent than in the first instance, but under a somewhat different condition.

If we take a clean copper wire, and dip it into a solution of the sulphate of copper, on taking it out, we find no preceptible difference is made on its surface. If we now take the copper wire, or slip of that metal, and solder to one of its ends a piece of zinc, and bend the two metals so combined into the shape of the letter u, and again place the copper end in the cupreous solution, and the zinc end in a very weak solution of salt and water,—if allowed to remain some time, it will be found the copper end has received a thin coating of solid copper. In this instance, as in most others connected with continued galvanic arrangement, it is a *sine qua non*, that the two fluids must *not* be allowed to intermingle, yet must be *in* connection with each other.

To effect this, various expedients have been resorted to, with more or less success; but to give a simple illustration of how this may be effected, in order to attain the result mentioned above, take a piece of *stout* brown paper, and bend it into the form of a piece of tube about three inches long, and perhaps an inch in diameter. This may be conveniently done, by bending the paper round a phial to make it assume the desired form; let the edges of the paper overlap, and fasten them together with a bit of sealing wax. A paper tube is thus obtained, open at both ends, but one end must be closed; this may be done simply, by cutting a piece of card into the shape of the bottom end, but a little larger, and fastening it on with sealing wax, just as we would take an impression of a seal, by covering the disc of card with the wax, and while soft dip the end of the paper tube into it; when set, we shall thus obtain a vessel capable, to a certain extent, of containing a fluid, yet, from its porous texture, this fluid would be in connection with any other fluid that might surround it on the other side.

Having obtained such a tube, we three parts fill it with salt and water, or better still, glauber salt and water, which is a sulphate of soda. We then take a common drinking tumbler, containing a quantity of sulphate of copper in solution, and take the paper tube containing the saline solution, and immerse it in the tumbler, taking care that both fluids shall attain the same level. If we now take the bent slip of copper and zinc, and place the copper end of it in the cupreous solution, and the zinc end in the saline solution, contained in the paper tube, and let this remain at rest for a few hours (if in a warm situation so much the better) it will be found on removing the combined pieces of metal, that the copper end has obtained a solid covering of pure copper, I have here described an elementary voltaic battery,—and the most extensive one ever constructed, is only a combination of such simple arrangements connected together by copper wires.

In this arrangement the inside of the paper tube, containing the saline solution, is termed the positive cell,—the outside one—the tumbler containing the cupreous solution,—is termed the negative cell. The zinc end of the combined metals, is termed the positive electrode,—the copper end, the negative electrode. With a modification of this very simple apparatus, all the experiments of this process may be readily performed. I have judged the above explanation necessary, as many persons have imagined the apparatus when constructed, was in some way or other connected to a galvanic battery.

By performing the above experiment, we acquire a clear idea of voltaic arrangement, while the eye becomes acquainted with the phenomena produced.

Were I required to produce an exact fac-simile of a medal in copper, I should proceed as follows:—Suppose it were equal in size to half-a-crown, —I should procure a piece of glass tube, (a short gas glass of the largest diameter does best) and then take a piece of flat glass and oil its surface slightly,—this done, I place one end of the tube on the oiled glass, and pour into it some fluid plaster of paris, to the depth of half or five-eighths of an inch; when this sets, the oiled glass will easily slip off, and a porous bottom will thus be given to the tube, which in all cases should be of equal or superior diameter to the medal required to be copied. This, and a common size drinking tumbler, comprehends nearly all the apparatus required.

I should now procure two pieces of pretty thick sheet lead, and with a plane, smooth one of the surfaces of each piece, in the manner wood is planed. I then take the medal to be copied, and place it between the bright surfaces of the pieces of lead, and place the whole under a press. Should the medal not be very large, a copying press will be found sufficient, but when larger, a more powerful one is requisite. In either case the object to be acted on must be under the centre of pressure.

When removed from the press, a most exact mould of each side of the medal will thus be obtained. I now take a piece of copper wire, varying in length according to the size of the apparatus,—in the present instance, from 12 to 16 inches may be used. To one of its ends, I solder a piece of zinc, rounded, and sufficiently large to go into the gas glass. To the other end I solder\* one of the leaden moulds. I have now what is termed a “galvanic pair,” the leaden mould constituting the negative electrode, and the zinc the positive one.

The wire is now bent in such a form, that the lead and the zinc will be opposed to each other,—the opposed surfaces being distant about  $1\frac{1}{2}$  inches. To effect this, bend the wire into a right angle, at its junction with the lead, and place the lead in a horizontal position, at the bottom of the tumbler,—the impressed side being uppermost. The gas glass, with its plaster bottom, must now be placed exactly over the lead mould.† The wire must again be bent in the shape of the letter *u*, in order that the zinc end may go into the gas glass, and *touch*, or nearly so, its plaster bottom. This like the lead, must lay horizontally, on the bottom of the interior cell. To conveniently effect this, the end of the wire should be soldered to the centre of the zinc disc.

These arrangements being neatly effected, I now pour a hot saturated solution of sulphate of copper into the tumbler, being in connection with the lead.—A few undissolved crystals may be added with advantage.—I next pour a hot solution of glauber salt into the gas glass, in connection with the zinc, taking care it does not exceed the level of the fluid in the outside cell. This latter solution must not be saturated, but only a few crystals of the salt put in the water. This may now be allowed to remain for a day or two, until the blue colour of the cupreous solution is assuming a pale green; then add a few crystals of the salt of copper.—Should a very thick deposition of

\* The wire should be soldered to the blank side of the lead.

† In order that the gas glass may not *rest* on the plate to be deposited on, I suspend it by a wooden collar, which rests on the outside vessel, and keeps the bottom of the inside one, at a quarter of an inch distant from the plate.



copper be required, it is well to renew the solutions entirely, as the acid that is set free, materially interferes with the success of the process.

This process may be quickened in a very great degree, by the application of heat, and the metal so deposited, is of a much superior character to that deposited under a common temperature. The apparatus I have described, may be kept at a temperature of from 120 to 160°, by being placed at the side of a fire, and a deposition got in a very few hours.

When it is judged the requisite thickness is deposited, I proceed to get the copper so deposited, off the mould, as follows:—Previous to immersing the lead into the solution, I generally varnish the back and edges of the mould, to prevent deposition on any other portion of its surface than that opposed to the zinc.

On removing it from the apparatus, I file the edges of the copper until they are flush or parallel with the lead. I then heat the copper side by holding it over the fire, and suddenly plunge it in cold water. On examination it will be found some portion is loosened from the lead, when, by inserting the edge of a knife, the plate of copper will come readily off, bearing a *most exact* impress of the original.

I have thus far described how to proceed, in the process of taking a single medal; but it will at once be perceived, that the same instructions apply to a sheet containing an indefinite number, by only enlarging the apparatus. By exactly the same process here described, I have succeeded in obtaining exact copies of engraved wood blocks and copper plates. I have also succeeded in stereotyping in copper, some elaborate ornamental printing, equal in area to a large octavo page.

I have used lead for most of my latter experiments, instead of copper,—as that metal precipitates copper, when in connection with zinc, and it is much easier got off the mould, in consequence of the different degrees of expansibility possessed by the two metals, on the application of heat. The time occupied by the whole process, is also materially abridged. I have not yet had an opportunity of trying the “fusible metal,” that melts at a temperature of 212° Fahr. It must also be borne in mind, that as far as our knowledge extends, it is an electro-chemical law, that a *metallic* surface must be present, before we are able to precipitate a metal from its solution.

Want of space compels me to omit several minutiae, that my experience has suggested, but enough has been said to illustrate the principle, and I may add, it is susceptible of infinite variation.

I have every reason to believe it might be found advantageous to type foundry, for the matrix from which they cast type, as copper precipitates very readily, on a surface of type metal.

In conclusion, I may add,—I have no personal intention of turning this process to pecuniary advantage,—should it be capable of being so applied, but should at all times feel happy in communicating my experience of the matter to those desirous of applying it in the arts.

My own expectations have been fully realized, as it has been a means of illustrating a hitherto unsolved geological problem, in connection with some peculiar views I hold on the subject.

THOMAS SPENCER.

Liverpool, Dec. 14th.

Ibid.

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*On the Nature of Yeast and Fermentation.* By DR. URE.

Yeast, according to my observations, when viewed in a good achromatic microscope, consists altogether of translucent spherical and spheroidal par-

ticles, each about the 6000th part of an inch in diameter. When the beer in which they float is washed away with a little water, they are seen to be colourless; their yellowish tint, when they are examined directly from the fermenting square or round of a porter brewery, being due to the infusion of the brown malt. The yeast of a square newly set seems to consist of particles smaller than those of older yeast, but the difference of size is not considerable. The researches of Schulze, Cagniard de la Tour, and Schwann, appear to show that the vinous fermentation, and the putrefaction of animal matters—processes which have been hitherto considered as belonging entirely to the domain of chemical affinity—are essentially the results of an organic development of living beings. This position seems to be established by the following experiments:—1. A matrass or flask containing a few bits of flesh being filled up to one-third of its capacity with water, was closed with a cork, into which two slender glass tubes were cemented air-tight. Both of these tubes were passed externally through a metallic bath, kept constantly melted, at a temperature approaching to that of boiling mercury. The end of one of the tubes, on emerging from the bath, was placed in communication with a gasometer. The contents of the matrass were now made to boil briskly, so that the air contained in it and the glass tubes was expelled. The matrass being then allowed to cool, a current of atmospheric air was made constantly to pass through it from the gasometer, while the metallic bath was kept constantly hot enough to decompose the living particles in the air. In these experiments, which were many times repeated, no infusoria or fungi appeared, no putrefaction took place, the flesh underwent no change, and the liquor remained as clear as it was immediately after being boiled. As it was found very troublesome to maintain the metallic bath at the melting pitch, the following modification of the apparatus was adopted in the subsequent researches. A flask of three ounces capacity, being one-fourth filled with water and flesh, was closed with a tight cork, secured in its place by wire. Two glass tubes were passed through the cork; the one of them was bent down, and dipped at its end into a small capsule containing quicksilver, covered with a layer of oil; the other was bent on leaving the cork, first into a horizontal direction, and downwards for an inch and a half, afterwards into a pair of spiral turns, then upwards, lastly horizontal, whence it was drawn out to a point. The pores of the cork having been filled with caoutchouc varnish, the contents of the flask were boiled till steam issued copiously through both of the glass tubes, and the quicksilver and oil became as hot as boiling water. In order that no living particles could be generated in the water condensed beneath the oil, a few fragments of corrosive sublimate were laid upon the quicksilver. During the boiling, the flame of a spirit lamp was drawn up over the spiral part of the second glass tube, by means of a glass chimney placed over it, so as to soften the glass, while the further part of the tube was heated by another spirit lamp, to prevent its getting cracked by the condensation of the steam. After the ebullition had been kept up a quarter of an hour, the flask was allowed to cool and get filled with air, through the hot spiral of the second tube. When the contents were quite cold, the end of this tube was hermetically sealed, the part of it between the point and the spiral was heated strongly with the flames, and the lamps were then withdrawn. The matrass contained now nothing but boiled flesh and gently ignited air. The air was renewed occasionally through the second tube, its spiral part being first strongly heated, its point then broken off, and connected with a gasometer, which caused the air to pass onwards slowly, and escape at the end of the first

tube immersed in the quicksilver. The end of the second tube was again hermetically closed, while the part interjacent between it and the spiral was exposed to the spirit flame. By means of these precautions, decoctions of flesh were preserved, during a period of six weeks, in a temperature of from  $14^{\circ}$  to  $20^{\circ}$  R. ( $63\frac{1}{2}^{\circ}$  to  $77^{\circ}$  F.), without any appearance of putrefaction, infusoria, or mouldiness: on opening the vessel, however, the contents fermented in a few days, as if they had been boiled in the ordinary manner. In conducting such researches, the greatest pains must be taken to render the cork and junctions of the glass tubes perfectly air-tight. The following more convenient modification of the experiment, but one equally successful and demonstrative, was arranged by F. Schulze. The glass tubes connected with the flask, were furnished each with a bulb at a little distance from the cork; into one of which globes caustic alkaline lye being put and into the other strong sulphuric acid, air was slowly sucked through the extremity of the one tube, while it entered at the other, so as to renew the atmosphere over the decoction of flesh in the flask. In another set of experiments, four flasks being filled with a solution of cane-sugar, containing some beer yeast, were corked, and plunged in boiling water till they acquired its temperature. They were then taken out, inverted in a mercurial bath, uncorked, and allowed to cool in that position. From one-third to one-fourth of their volume of atmospheric air was now introduced into each of the flasks; into two of them, through slender glass tubes kept red hot at a certain point, into the other two through glass tubes not heated. By analysis it was found that the air thus heated contained only 19.4 per cent. of oxygen, instead of 20.8; but to compensate for this deficiency, a little more air was admitted into the two flasks connected with the heated tubes, than into the two others. The flasks were now corked and placed in an inverted position, in a temperature of from  $10^{\circ}$  to  $14^{\circ}$  R. ( $54\frac{1}{2}^{\circ}$  to  $63\frac{1}{2}^{\circ}$  F.) After a period of from four to six weeks, it was found that fermentation had taken place in both of the flasks which contained the non-ignited air—for, in loosening the corks, some of the contents were projected with force—but in the other two flasks, there was no appearance of fermentation, either then or in double the time. As the extract of nux vomica is known to be a poison to *infusoria* (animalcules,) but not to vegetating mould, while arsenic is a poison to both, by these tests it was proved that the living particles instrumental to fermentation belonged to the order of plants of the Confervoid family. Beer yeast, according to Schwann, consists entirely of microscopic fungi, in the shape of small oval grains of yellowish white colour, arranged in rows oblique to each other. Fresh grape must contain none of them; but, after being exposed to the air at  $20^{\circ}$  R., for thirty-six hours, similar grains become visible in the microscope, and may be observed to grow larger in the course of an hour, or even in half that time. A few hours after these plants are first perceived, gas begins to be disengaged. They multiply greatly in the course of fermentation, and at its conclusion subside to the bottom of the beer in the shape of a yellow white powder.

Athenæum.

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*On a new Method of distinguishing Arsenic from Antimony, in cases of suspected poisoning by the former substance. By MR. J. MARSH.*

In testing for arsenic in cases of poisoning by that substance, it has always been desirable to render the process as simple as possible, and thereby divest the mind of any ambiguity on the subject. It was with this view that



I submitted to the Society of Arts, &c. in the year 1836, my process by hydrogen, a process that I then fondly hoped would have removed all difficulties, but a communication from my friend Mr. Lewis Thompson, and which was inserted in the *L. and E. Philosophical Magazine*, vol. x. p. 353, has rendered the process in some measure more difficult than was at first supposed, by the discovery of that gentleman, of a compound in which antimony combines with hydrogen to form a gas (antimoniuretted hydrogen). This gas gives off by the process employed, metallic crusts, which much resemble, to the inexperienced eye, the metallic substance obtained from arsenical solutions by the same arrangements. It becomes necessary therefore to find a means of distinguishing these metallic crusts from each other. Many processes which are well known to the experienced chemist may be employed for this purpose; but the misfortune is that all these arrangements suppose a previous chemical acquaintance with the subject; for instance, a good process for this purpose is given by Liebig and Mohr in their valuable *Journal* (Lieb., *Ann.*, xxiii. 217.) and also a modification of the same, by Berzelius, may be seen copied in the *Lancet*, vol. i. 1838, p. 819, but these are all liable to the above objection, viz. want of simplicity.

I am happy in being able to lay before your readers a very simple distinguishing test for these bodies, and which I have employed in all cases of doubt with perfect success. The means that I use is simply as follows: After the common arrangements have been made for testing for antimony or arsenic, the piece of glass or porcelain on which the metallic crusts are generally received, is to have a single drop of distilled water placed on it; the glass or porcelain is then to be inverted, so that the drop of water is suspended undermost. The gas as it issues from the jet is to be inflamed in the usual manner, but the piece of glass, &c., with its drop of water, is to be held about an inch above the jet, or just above the apex of the cone of flame: the arsenic by this arrangement is oxidized at the same time that hydrogen is undergoing combustion, and coming in contact with the drop of water held above, forms with it a strong or weak solution of arsenical acid, according to the quantity of arsenic present, should that substance have been in the mixture submitted to examination. A very minute drop of Hume's test (the ammoniacal nitrate of silver) being now dropped on the solution so obtained, if arsenic be present, the well-known characteristic lemon yellow colour produced by this test when used for testing for that substance is immediately produced, namely, the insoluble arsenite of oxide of silver. Antimony under these circumstances, from being insoluble, produces no change. I have found it useful, when much arsenic has been present in the matter submitted to examination, to use a clean glass tube, six inches long, and about half an inch in diameter. I slightly moisten the interior of the tube with distilled water, not allowing the hands or fingers to come in contact with the water: the tube thus prepared is to be held vertically over the apex of the jet of burning gas. By these means a strong solution of the substance is obtained, and which may be tested with perfect ease by Hume's test, or any other of the usual tests employed for arsenic, &c.

I hope that the foregoing process will be found to possess all the delicacy and precision necessary for distinguishing these two bodies from each other, and that it will be the means of removing every doubt from the minds of the experimentalist in future.

Royal Arsenal, Woolwich, June 21, 1839.

J. M.  
*L. & E. Philos. Mag.*

*On the separation of Lime from Magnesia, and on the Assay of Gold.* By  
LEWIS THOMPSON, Esq., M. R. C. S.

*To separate Lime from Magnesia.*

Dissolve the combined earths in dilute nitric or muriatic acid, and precipitate the filtered solution by means of an excess of carbonate of soda; dry the precipitate, and place it in a coated green-glass tube, so disposed that the whole can be heated to a dull red heat; when red hot pass a current of well-washed chlorine through the tube for a few minutes: the lime will be converted into chloride of calcium, but the magnesia remains unacted upon. When the whole is cool, remove the mass from the tube and boil it for a minute or two in water, filter the liquid and wash the insoluble portion (which is magnesia) with water, and precipitate the lime from the mixed liquors by carbonate of soda. The heat should not exceed a dull red, as the mass is apt to become vitrified at the part which touches the tube, and this renders it difficult to remove the contents.

*To Assay Gold.*

Take six grains of the gold to be assayed and place it in a small crucible, with fifteen grains of silver, and from eight to twelve grains of chloride of silver, according to the supposed impurity of the gold; lastly add fifty grains of common salt (chloride of sodium) reduced to a fine powder so as to prevent decrepitation; fuse the whole together for five minutes, and allow it to become cold; then take out the metallic button and beat it into a thin plate, and subject it to the action of dilute nitric acid as in the ordinary mode of parting. By this plan the tedious process of cupellation is avoided, the baser metals being wholly removed by the chlorine of the chloride of silver, and their place supplied by pure silver.

Ibid.

*Manufacture of Salt.*

The Dutch are remarkably particular as to the quantity and quality of the salt which they use for dairy purposes, and of which there are three kinds manufactured. The first is somewhat smaller than our common salt, and is boiled or evaporated in twenty-four hours. This is used for butter. The second is evaporated in about three days, and is used in salting cheese by outward application. The third is beautifully formed in crystals, of about half an inch square, and the evaporation lasts four or five days. It is sometimes used for salting cheese, but principally for fish, beef, and pork. There appears to be some secret in the process, which the manufacturers are unwilling to disclose; but it is certain, that the use of the Dutch salt is one of the causes of the sweet and delicious flavour of Dutch butter, which hardly tastes of salt, or rather of that acrid quality which the muriate and sulphate of magnesia pervading our common salt impart to our butter. Considering how important an article salt is, it is rather remarkable, that though chemistry has advanced to such perfection, no change has taken place in the mode of making it for several centuries. The late Earl of Dundonald, Dr. Coventry, and the Rev. James Hendrick, proposed important improvements in this manufacture, but they seem never to have been adopted.—*Royal Cornwall Gazette.*

Mining Jour.

*Action of Æther on Indigo. By M. VOGEL.*

I had more than once remarked by chance that when the vapour of æther is passed into a solution of indigo in sulphuric acid largely diluted with water, it was decolorated. This effect is produced more readily when the æther is heated to ebullition in a matrass furnished with a bent tube which is immersed in the solution of indigo; and if the matrass be suddenly cooled, so that the solution of indigo rises in the tube and passes into the matrass by the pressure of the air. When I attempted on another occasion to decolorate indigo by means of æther which had been rectified over potash, I could not so readily effect it, which induced me to believe that the impure æther, which contained sweet oil of wine, or probably aldehyd, was more fit for the decoloration of indigo than pure æther.

To satisfy myself, I added to a solution of indigo in a bottle a few drops of aldehyd, and I remarked that the liquor, at first of an emerald green colour, became of a pale green, and after some days became of a yellowish brown. As the aldehyd which I employed contained alcohol, it not having been rectified, I afterwards made use of pure aldehyd, which was separated from its crystalline combination by ammonia: a few drops of this pure aldehyd were sufficient to destroy the blue colour of indigo in a very short time, the solution becoming of a straw yellow. When the aldehyd was evaporated by heat, the blue colour could not be made to reappear. The addition of potash, and of red oxide of mercury, were not capable of restoring the blue colour. On evaporating the decolorated liquor there remained a brown substance analogous to ulmin. This decoloration of indigo by aldehyd occurs only when the indigo is dissolved in sulphuric acid. Indigo in fine powder, diffused through water, undergoes no change by aldehyd: neither the tincture of litmus, nor the spirituous tinctures of cochineal or turmeric, are decolorated by aldehyd.—*Journal de Pharm. Mars 1839.*

*Ibid.*

## Progress of Civil Engineering.

*The Cockerills of Liege.*

William Cockerill was a working black-smith, in England. He was constantly bent upon important mechanical designs, which he longed to have the means and opportunity of putting into execution. As often happens, nevertheless, William Cockerill met with little encouragement in the scene of his early labours, and towards the close of the last century, when he had attained middle life, and surrounded himself with a family, he migrated to the continent. Along with some other skilful mechanics, he proceeded, by the permission of our government, to St. Petersburg, with the view of following out certain plans of the Empress Catharine, for establishing manufactures in her dominions. The death of the Empress, and the accession of the madman Paul, ruined his prospects in Russia, and after a time he made his escape to Sweden. Here, under the protection of the British envoy, William Cockerill was employed as engineer on some public works, which no native Swedes could undertake. Engineering, however, did not suit his genius, and hearing of the manufactures of Liege and Verviers, in Belgium, which were flourishing in spite of defective mechanism, he imagined that, if he were in either of these places, he should be certain to succeed as a constructor of machines. He proceeded first, as we are told, to



Hamburg, where he disclosed the plan of his proposed operations to Mr. Crawford, the English consul—at the same time stating, “that if he could obtain a small pension from the British Government, he would return to England, not wishing to do any injury to his country, by introducing machinery into a foreign one.” Mr. Crawford, it appears, approved of the proposal, and communicated it to the Ministry; but no answer being returned at the end of six months, Cockerill proceeded to the Netherlands, there to seek fortune with his own head and hands.

He made offers to some extensive woollen manufacturers of Verviers, a town within the province of Liege, to construct for them new machines of his own invention for the carding and spinning of wool, and for other purposes connected with the production of cloth fabrics. The offers were accepted, and William Cockerill forthwith brought his family from England, and settled with them in Belgium. Cockerill’s sons were now growing up, and, with the assistance of their hands and his own, he speedily executed all orders, and founded a thriving establishment. The workshop of the Cockerills at Liege became a famous one, and the quantity of machines made for various manufactures was soon very considerable.

In the year 1813, the elder Cockerill retired from business, with a handsome fortune, leaving his two sons, James and John Cockerill, to follow out his trade. They did so for several succeeding years, and at length James also retired with a competency. John, who was now left alone, and who is said to possess the most enlarged mind of them all, erected, in 1815, the first manufactory for steam-engines which had been seen, on a large scale at least, in Belgium. His machines were soon distributed over the whole continent; but this was done far more extensively afterwards when he erected new iron-works of vast size at the village of Seraing on the Maese, distant a few miles from the city of Liege. The magnitude of this establishment may be conceived from the fact that it keeps in continual motion sixteen steam-engines, of the collective force of 900 horse-power, and employs 3000 workmen. This establishment was organised by John Cockerill between the years 1821 and 1823. Yet, immense as are the operations here conducted, numberless as are the railway projects here perfected, and the steam-engines and machines of all sizes and descriptions here constructed, the establishment of Seraing is but one of the many great concerns which John Cockerill superintends, and of which he is wholly or in part proprietor. He still keeps in action the extensive foundry, originally possessed by his father in Liege; holds large shares in mining and colliery establishments; and possesses large cotton-spinning factories, as well as linen-manufactories, where these stuffs are put into all forms, weaving and printing included. He is also the proprietor of a paper manufactory. All these establishments he in a measure superintends in person, but, at the same time, it is especially remarked of him that he takes care to have the best of servants and overseers, sparing no expense in bringing such persons from all countries of Europe to his various works.

Such are the concerns of John Cockerill, and such are the sources of capital and material which lately enabled him to come forward, unassisted and unrivalled, to offer himself as the contracting party with the French Government for the laying down of a railroad between Paris and Brussels; perhaps the most stupendous enterprise of the kind ever undertaken by an individual. This remarkable man, if we may trust to the accounts given of him, is not stimulated in his career of enterprise merely by a desire of personal emolument or aggrandisement, but seemingly regards himself, and

acts, as one who has a great mission to execute, that, namely, of peopling the world with machines for the spreading of wealth and comfort among its inhabitants.

There are internal meliorations in the condition of the workmen peculiar to Mr. Cockerill's works, and solely due to his sagacity and genius, at once inventive, bold, and benevolent. Such comforts, for instance, as the robing or clothing-rooms, where the workmen hang up their out-of-door clothes when they come, and their working ones when they go away. Every workman has his place marked by a certain number, and a placard with his name. This is transplanting the habits of the business-office into the workshop. But what is most striking is a large hall in the centre of the works, with a stove in the middle of it, neatly ornamented like most of the Belgian stoves; and upon this stove, morn, noon, and eve, there hangs a kettle filled with warm coffee. It is in this hall that all the workmen meet at certain hours of the day, in the intervals of labour, and take their coffee, men and foremen together, the latter holding a certain moral presidency, which the others willingly acknowledge. They here chat without noise or quarrelling, until the sound of the clock calls every man to his duties again.

Lond. Mech. Mag.

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*Advantages of Anti-friction Machinery.* By MR. COLES.

The lecturer commenced by showing the necessity of all four-wheel carriages being made to move on pivots in the centre of their axles, instead of being fixed and immoveable, *as at present constructed*. He then showed that the off-wheels of an ordinary railway-carriage, when working round a circle of 23 yards radius, would lose 10 inches and a half every revolution they made, *even when working on moveable axles*, and they could not make many revolutions upon any curve without running foul of the rails, and thus the engine would have to contend with an enormous amount of friction; one-half of the wheels of each train would press with their flanges against the rails, as also an increase of friction in the bearings of the axles, by the wheels being thrown obliquely in their bearings.

To obviate which he introduced models of a new step-rail, which may be made of cast-iron, thus: an indentation or step is sunk down on the inner edge of the rail of about one-third its width and half an inch deep in the highest, and about three-quarters in the lowest part. The step of the rail for working curves would be so low down as never to come in contact with the rim of the wheel in working straight lines, nor when working the inner curve. The flange, or largest part of the off-wheel, runs entirely on the step of the rail when working a curve of 23 yards radius; but if working a curve of twice that size it would work one-half on the plain part of the rail, and the other half on the step, which would be undulated, having hills and valleys of equal distance, by which the wheels would run parallel to each other, and thus work clear of the rails and cause no side friction; and rails may thus be formed to suit any curve; the principle of securing the rail to its bearings is both novel and ingenious, and which is particularly described in an "Essay on Locomotive Traveling."

The lecturer then demonstrated more fully his principle of the traversing axles of the four-wheel carriages, from which it appeared manifest that by fixing a stout iron bar to the collars or bearings of the axles, the wheels being outside the frames, such bars would work up and down the grooves with their collars, whilst their axles would revolve in their collars as before

and to these bars two other bars would be attached, something in the shape of a quadrant, which meet each other between the two axles and form a union or knuckle-joint, each part would be operated upon by the rail and thrown diagonally with their axles into right angles with the curve of the rails, room being allowed in the grooves in which the wheels work, to admit of their moving backwards or forwards; the point of resistance is thus transferred from the sides of the carriage-frame to the pivots in the cross-stays on which the axle-bars move; two loops would be attached to the edge of all the axle-bars, about five inches from their collars; the bars being wider than the cross-stays, two bolts would pass through these loops to key them together, and keep them perpendicular over each other, that they shall all move in the same direction.

He next elucidated the foregoing principle of the traversing axles, by exhibiting to the audience a four-wheeled locomotive, with the axles placed into the frame diagonally to such an angle as was required to work round a circular iron railway thirty-four feet six inches in circumference, the off-wheels being seven-eighths of an inch larger in the periphery of the wheels than the inner wheels, which is precisely the same thing as if the periphery of the wheels had been turned both of a size and the flange left on. *The rail and carriages being made on a scale of one inch to the foot.* A two-wheel carriage laden very heavy was attached to the locomotive, and when set in motion they traversed round the circle in five seconds, or at the comparative rate of fifty miles in an hour. He next explained the nature of working them by manual labour, and showed that by fixing a handle to a spoke of the large anti-friction or driving wheel, they may be propelled with immense velocity, the friction being transferred from the ground wheels, which revolve seventy-five times, to the upper wheels, which only revolve once, thereby proving that there would be scarcely any wear in the working wheels. He next exhibited a four-wheel carriage, on which a man propelled himself by turning the wheels as he sat upon it. Mr. Coles then placed 168 lbs. weight upon the carriage, and placed it upon a level iron plane, and attached a six ounce weight and brought it over a pulley which propelled it, the weight was then taken off and the common wheels were employed, and the aforesaid load of 168 lbs. placed upon it, and it required eight times greater power, viz. forty-eight ounces to propel it; thus clearly demonstrating that one pound power is equal to eight pounds now on railways, or sixty-four lbs. *on the common roads*, the advantages are of a like proportion if employed on the common roads, and, *this* increase of power is gained by the reduction of friction in the axles alone, leaving for future experiments to show what friction remains to be got rid of between the flanges of the wheels and the rails, which is easily accomplished by the use of a step-rail and traversing axles.

The lecturer further showed that his patent anti-friction machinery is about to be applied to vessels and other machinery, for which he has also a more recent patent, when the combined force of manual labour and steam may be employed with considerable advantage. The steam power to drive one pair of paddle-wheels, and manual labour the other pair, by which two thirds of the fuel may be saved, the motion of the friction wheels being nearly ten times slower than the slowest motion of the carriage wheels, which we need not repeat.

Railway Mag.



*Anthracite Iron.*

We have again, in our past two Numbers, observed on the increased application of anthracite, or stone coal, which more particularly abounds in South Wales, Ireland, and America. Looking to those districts at home where this description of fuel is most plentiful, it is a matter of surprise that works have not been erected upon an extensive scale for carrying out Mr. Crane's patent for making iron by the use of hot-blast with anthracite. Having had an opportunity some months since, of visiting the Yniscledwyn works, we there saw three furnaces in active operation, the one producing iron from anthracite alone—another having two-thirds of that material, the remaining third being coal of a bituminous nature—and the latter, worked solely with bituminous coal, yielding a weekly "make" of 140 to 150 tons.

The result of our inquiries made on that occasion from the proprietor, whose courtesy it affords us pleasure here to acknowledge, was, that the iron produced from the stone coal was most in esteem, as possessing tenacity and strength, and that the only cause then assignable of any other description of coal being used, was the inability, at that time, of obtaining a sufficient supply of anthracite, which, however, we have reason to believe, has since been removed, and to which our attention has been directed by Mr. J. Johnson, of Liverpool, a gentleman to whom we are indebted, on a former occasion, for an interesting paper "On the Iron Trade." Works were then in course of erection (the Ystal-y-fera) within some six or seven miles of the Yniscledwyn works, which were being carried on by a Liverpool Company, projected, we believe, by Mr. Manby, the (late) engineer, Mr. Budd, of Liverpool, and Mr. Bevan, of Swansea, the latter being the present manager or superintendent, and whom we had the pleasure of meeting on the spot. These works promise to be of an extensive character, and a railway is laid down from the collieries to supply the furnaces, which we were given to understand were to be worked with stone coal, on the principle patented by Mr. Crane. Only one furnace, we believe, is at present in action, and that with a limited proportion of stone coal, in the manufacture of pig-iron or castings. We have not accurately learned the reason, but believe it is attributable to want of supply, and thus not affecting the question of the applicability of stone coal to the manufacture of iron—a fact, indeed, incontestibly proved by Mr. Crane's patent, which has been so successfully carried out at the Yniscledwyn works.

We have not space this week to enter so fully, as is our wish, into detail, but cannot leave the subject without adverting to a matter which, to us, would appear to reflect discredit on the capitalists and iron masters of South Wales generally. We refer more immediately to those connected with the anthracite coal-field. With facts before them, such as must remove the doubts of the most sceptical, strange is it that we do not find the possessors of the mineral or the capitalist disposed to avail himself of the advantages which are so self apparent to arise from a judicious outlay of capital in an immense coal-field, with abundance of ironstone, and possessing the advantage of water communication. How is this to be accounted for?—is the natural question which arises in the mind of every one who gives the matter one moment's consideration; and to this we can only offer one reply, and that so impotent, that we are at a loss to afford those satisfactory reasons which might be expected from us, accompanied by a remedial measure. The only

reason we can advance is the long contested right of patent, and the forthcoming trial of "*Crane v. Price.*" It would be improper at this moment to enter into the merits of this cause—suffice it to say, that the Messrs. Price, the defendants, contend that Mr. George Crane cannot maintain his patent, although they are, as must all parties be, ready to admit that Mr. Crane has, at considerable cost of money and application of time and labour devoted to the subject, brought about the successful results, of which the defendants are desirous of obtaining the benefits—the advantage sought by the patentee (we believe a royalty of one shilling per ton on iron) being disputed by them. We know on which side equity and justice lie, but what construction may be put on the Patent Laws, or what quibble may be raised by counsel, we are not prepared to say; and we fear that this contention has prevented parties from availing themselves of Mr. Crane's patent, being anxious to avoid paying so *exorbitant* a royalty, and, therefore, await the issue of the trial.

Mining Jour.

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### *Locomotives on Common Roads.*

#### REPORT OF THE COMMITTEE.

The committee, after some preliminary observations, thus describe the apparatus of the locomotive of M. C. Dietz:—

The apparatus is principally composed of two steam cylinders united to a tube-shaped boiler, similar to those of other locomotives, but with a circular furnace, according to the plan of M. Bury. The action of the steam is communicated by means of two pistons attached to transverse cranks; but the movement does not bear directly upon the axle-tree as in other locomotives; and this is not the only distinction of the Dietz Remorqueur; it bears upon the ground in a manner totally different from other engines. It is hung on eight wheels, six of which are less than the others. The six small wheels are constructed like the castors of a bedstead, and are distributed at each end of the engine, the weight of which thus divided is supported by them. Between each of these wheels and the body of the remorqueur are springs of very great strength, but which are so adapted as to have considerable play. These small wheels may be considered as almost exclusively employed for the hanging of the engine,—that is, they may be forced by the springs into every accidental cavity on the road, and thus they support in a great degree, the principal share of the weight. The six small wheels are connected together so as to assist in guiding the engine by a mechanism which causes the forewheels to converge simultaneously in one direction, whilst the hind wheels are in an inverse position, and it is turned to the right or left, as occasion may require, without any violent effort, by the steering apparatus. In this remorqueur the impulse is given by the adhesion of the two larger wheels to the ground, for which purpose they are not shod with an iron tire in the ordinary way, but are encircled with pieces of wood placed upright in juxta-position, and inserted laterally between two circular pieces fastened to the sides of the felloes.

The wheels are put in motion by means of a strong endless chain; and this kind of motion allows the body of the locomotive to oscillate upon the numerous springs which support it, and to follow every change in the direction of the wheels, without the least disturbance of the mechanism.

On the day of trial the remorqueur, of the construction of which we have just given the principal particulars, was followed by its tender, and by a large diligence capable of containing a number of persons.

The plan of connecting the carriages with each other is deserving of notice; they are obliged to follow the track of the remorqueur, which is absolutely essential in a long train guided only by the conductor of the remorqueur.

As soon as your committee were seated in the coupe of the diligence, the train started. The resistance at starting was overcome with great facility, and the train proceeded rapidly down the Boulevard Extérieur, which leads to the Invalids. During the progress, either on purpose, or in order to avoid collision with other carriages, the train was compelled several times to move from the paved to the unpaved part of the road, and back again; and this was done not only without difficulty but without any perceptible diminution of speed; and an unexpected obstacle afforded an opportunity of proving the power of the remorqueur, which, in the course of its progress, had to pass over a heap of rubbish thrown out of some excavations which were making in order to repair the high roads.

The experiment was continued in the Champs-Élysées by ascending and descending the slope in the avenue of the Étoile, which is rather steep; and your committee had occasion to remark the ease with which the train turned round to go in an opposite direction. After these different trials, they thought the experiment had been sufficiently prolonged to enable them to judge of the merits of the apparatus submitted to their examination. The excellent way in which it was hung was apparent to them the moment this heavy engine passed over deep kennels without jolting or shaking. The return of the train to the station, through a small gateway in a narrow street, furnished a fresh proof both of the possibility of guiding the remorqueur, and of the skill of the MM. Dietz, brothers, as conductors.

The train passed through the Boulevards, the Champs-Élysées, and even the streets, in the same way as ordinary carriages. The average speed, which was increased or decreased at pleasure, was 15,000 metres (more than twelve miles) an hour; that is a little less than four leagues of 4,000 metres.

Your committee can say nothing respecting the expense of fuel, nor have they received sufficient information to enable them to point out the relative advantages and disadvantages of this system of locomotion, as compared with that of railways, or on common roads with horses. And in bringing under your notice the manner in which this invention of MM. Dietz overcame all the obstacles which it met with, and successfully contended against the practical difficulties of locomotion on common roads, your committee have thought it best to limit themselves to a statement of facts of which they were eye-witnesses, and the truth of which they can attest.—*Inventors' Advocate.*

Railway Mag.

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### *Gas Produced by a New Process.*

An experiment in gas-lighting by the Comte de Val Marino was made on Thursday evening on a piece of waste ground at the back of Fetter lane, in the presence of several scientific gentlemen, who were invited to witness the result. A small gasometer was erected for the purpose, which was connected by tubes with a furnace built of brick, and containing three retorts, one of which was supplied with water from a siphon, another was filled with tar, and both being decomposed in the third retort, formed the sole materials by which the gas was produced. The process appeared to be extremely simple, and the novelty of the experiment consisted in the fact, that the



principal agent employed to produce the gas was common water combined with tar; but according to the theory of the inventor of this new species of gas, any sort of bituminous or fatty matter would answer the purpose equally as well as pitch or tar. After the lapse of about half an hour employed in the experiment, during which time the process was explained to the company, the gas was turned into the burners, and a pure and powerful light was produced, perfectly free from smoke or any unpleasant smell. The purity and intenseness of the flame were tested in a very satisfactory manner, and those who witnessed the experiment appeared perfectly satisfied with the result. The great advantage of this sort of gas over that produced from coal consists, it was said, in the cheapness of the materials employed in its production, the facility with which it is manufactured, and the perfection to which it is at once brought, without the necessity of its undergoing the tedious and expensive process of condensation and purification; for in this instance as soon as the preliminaries were completed, the light was produced in a perfect state within a few feet of the gasometer, which although of inferior size, was said to be capable of affording light for ten hours to at least five hundred lamps or burners. With regard to the comparative expense, it was also stated that one thousand cubic feet of gas manufactured by this process, could be supplied to the public for about one-third the price now charged by the coal-gas companies, and it was said to be equally available for domestic use, and more safe than the common gas, inasmuch as small gasometers might, at a trifling expense, be fixed at the back of grates in private dwellings, from which the gas could be conveyed in Indian rubber bags to any part of the house, thereby preventing the many accidents which occur by the use of tubes and pipes. The count de Val Marino, who has conquered the difficulty hitherto experienced in bringing this species of gas into use, superintended the arrangements, and evinced a natural anxiety to bring his experiment to a successful issue. He has taken out a patent for his discovery, and he has improved upon the burners now in use, so as to render the light produced more pure and intense. For this improvement he is also secured by a patent. How far gas of this description can be brought into general use, or whether in point of economy the public would be benefited by its adoption, are questions which we have not the means of deciding, and, without hazarding any opinion on the subject, we can only say that the experiment, as far as it was tried in this instance, appeared to be quite successful.—*Times*.

Civ. Eng. & Arch. Jour.

### *Artesian Wells.*

In a paper on the wells found by digging and boring in the gravel and London clay in Essex, and on the geological phenomena disclosed by them, by Dr. Mitchell, F. G. S., the author gives the following list of the total depth of wells, selected from a very large number:—

|                            |      |       |
|----------------------------|------|-------|
| Stratford,                 | 247  | feet. |
| Ilford,                    | 301  | "     |
| Dagnam Hall,               | 404½ | "     |
| Brook street,              | 340  | "     |
| Upminster,                 | 192  | "     |
| Parsonage, Warley,         | 390  | "     |
| Grange Hill, near Fairlop, | 398  | "     |
| Dunton,                    | 344  | "     |

|                                                       |     |       |
|-------------------------------------------------------|-----|-------|
| Battle Bridge, . . . . .                              | 350 | feet. |
| Ferry-house on the Crouch, . . . . .                  | 360 | "     |
| Rochford Union workhouse, . . . . .                   | 330 | "     |
| Wakering Marshes, . . . . .                           | 400 | "     |
| Foulness Island { sand, 300 }<br>{ clay, 100 to 160 } | 460 | "     |
| Clay street, Walthamstow, . . . . .                   | 190 | "     |
| Loughton, in Epping Forest, . . . . .                 | 324 | "     |
| Epping, . . . . .                                     | 270 | "     |
| Horsley Park, near Ongar, . . . . .                   | 340 | "     |
| Bocking, . . . . .                                    | 370 | "     |
| Braintree, . . . . .                                  | 420 | "     |

This variation, the author conceives, is partly due to the unevenness in the surface of the chalk; but in some instances to the undulatory nature of the country, the difference in the depth of the wells agreeing with the increase in the rise of the ground. When this is the case, the bed in which the water is found is the same in the adjacent wells, and consequently the variation in the outline of the surface is due to denudation, and not to unequal elevation. Thus, in the two wells close to the turnpike at Romford, water was found at the depth of 100 feet, but half-way up the hill between Hare street and Havering Ate Bower at the depth of 250 feet; at Bocking it was obtained at 370, but at higher ground, at Braintree, close adjoining, at 420. Again, at the union workhouse in Rochford, the well is 330 feet deep, and at Stroud Green, on the road to Ruggleigh, where the surface is higher, it was necessary to sink 390 feet. At North Fambridge is a well 388 feet deep, the water rising to within 10 feet of the top: but at another well in the same parish, dug in lower ground, there is a constantly flowing stream.

There is, perhaps, no part of the world where artesian wells are more general, or are more useful than in Essex. In the vale of the Lea they have been bored with the greatest facility and at a small expense. In Waltham Abbey the cost is usually about 16*l*. In the district of Bulpham Fen, seven miles south from Brentwood, they yield a large supply of water. In the marshes, as well as along the coast, and in the islands of Essex, they have proved of the greatest utility. Formerly, in some seasons, when the ditches become dry, the cattle suffered, the fishes died, and the farmer lost severely on his stock; but by the aid of artesian wells the ditches are now kept full all the year, and the farmer and landlord are accordingly benefited. In Foulness Island there are no natural springs, and until lately no water, except atmospheric, collected in the ditches. In hot seasons this water became putrid, but the inhabitants and the cattle continued to partake of it as long as it lasted; and supplies were then obtained, at the distance of seven miles, from the east end of this island. Artesian wells now kept the ditches full of fresh and sweet water, labourers are obtained at reduced wages, and farmers of a higher class are beginning to reside on the island. Wallisea, Mërsea, and other islands have profited in a similar manner.

L. & E. Philos. Mag.

### *The Electro Magnetic Telegraph of the Great Western Railway.*

This telegraph, which is the useful and scientific invention of Mr. Cooke and Professor Wheatstone, of King's College, has been, during two months, constantly worked at the passing of every train between Drayton, Hanwell,

and Paddington. At the former station it, for the present, terminates. As soon as the whole line is completed the telegraph will extend from the Paddington terminus to Bristol, and it is contemplated that information, of any nature, will then be conveyed to Bristol, and an answer received in town in about twenty minutes. Merchants and others, residing not only at the two extremities of the line, but at any of the intermediate stations (at all of which dial plates will be fixed, with competent persons stationed to work the telegraph), will then be enabled to avail themselves of the benefits and facilities of Messrs. Cooke and Wheatstone's invention. Two of the boys from the Deaf and Dumb Asylum in the Kent-road have been at the Paddington station for five or six weeks, where they were instructed in the working of the machinery by Mr. R. Hutchinson, and they are now perfectly competent to superintend the telegraph at any one of the stations. A piece of machinery, simple but unerring, to which is attached a check-string to indicate to the boys when the signal is sent up to the line to show that something is about to be telegraphed, has been invented by Mr. Cooke, which enables these lads to perform this duty as efficiently as if they were not suffering under the deprivation of hearing and speech. The telegraph has now been in operation for nearly twelve months, and not the least obstruction to its working, by any of the wires, &c., becoming out of order, has yet occurred. Should such an event take place (especially when the whole line is open to Bristol) it might occur to many that there would be considerable difficulty (as all the wires are enclosed in a hollow tube, not more than about an inch in diameter) in ascertaining, throughout the 117 miles, the precise point at which the injury required to be prepared; but this apparent difficulty has been met by Mr. Cooke, who has invented a piece of mechanism which is contained in a mahogany case, not more than eight inches square, by which means the precise spot on the line where the injury might have been occasioned, would be indicated in an almost incredibly short space of time. The invention may now be termed perfect in all its details, and only awaits the completion of the line of railway to Bristol to bring it into full operation between that city and the metropolis.

Mining Jour.

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### *Gates for the Crossings of Railways.*

Mr. T. Lambert of Stockton-upon-Tees, has constructed a neat mode for gates, to be used at the crossing of railways. The gates turn on centres; and are so simple and complete, that one man can open both of them at one time with the greatest facility. When open, they prevent any one passing on the railway, and admit the progress of carriages, carts, etc., on both sides of the turnpike. Each gate is also furnished with an elevated circular signal, containing a lamp, which turns with the gate, so that whether it be night or day, persons at a great distance will be enabled to see when "danger" is announced. We have had the pleasure of examining the model, and can say with truth, that the invention seems to effect every thing necessary for the protection of life and property at crossings, while it allows the greatest facility for passing on the road.—*Sunderland Herald*.

London Mech. Mag.

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### *Railroads in Austria.*

M. Zanino Volta, the able engineer of Como, who, in conjunction with M. Bruschetti, of Milan, obtained, in 1837, from the Austrian government, a



privilege of fifty years for the construction of a railroad between Milan and Como, is now negotiating with the Swiss cantons of the Grisons and St. Gall an enterprize which would vie in magnitude with the Thames Tunnel, viz. the piercing through the Grisons' Alps. Impressed with the commercial importance of the passage of the Splugen, and at the same time with various obstacles which it presents, he thinks it possible to pierce through that mountain, and establish in the passage thus effected a railroad, the northern portion of which would end either at Wallenstadt, or even at Schmerikon, on the lake of Zurich; and the southern would be connected with the Como and Milan Railroad. M. Volta does not dissemble the expense and difficulties of such an undertaking, but insists on the immense advantages that would accrue from a horizontal road accessible at all times, and not nearly so long and fatiguing as the present one. As galleries above half a league long have already been bored, he deems that there is no reason why longer still should not be pierced. An examination has proved that the granite rocks to be gone through can be easily blown up, and that by a new process the operation may be rendered easier still. M. Volta, reckoning that thirty years will be required to execute the works, demands an exclusive privilege of a hundred years, with liberty to establish companies in order to procure funds or to transfer his privilege to other parties. In return he engages to execute 8000 metres in the course of five years, and the whole line, crossing the territory of the Grisons and St. Gall in thirty years. Moreover, M. Volta engages to pay 10,000 francs into the cantonal coffers of the poor for every year of unjustified delay in the construction of the first kilometre, or proportionately in the completion of the whole road over the Swiss territory, or else to resign entirely his privilege.

Mining Jour.

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*Fire Damp.*

It has been found by experience, that Sir H. Davy's safety lamp, though in many respects an invaluable discovery, has failed in proving a preventive to the explosion of fire damp in coal pits; and the frequent recurrence of accidents in the mining districts, evince the melancholy truth, that the precautions hitherto devised are incomplete. I venture therefore to propose a new process for abating an evil so fatal to human life, which is at least worthy of trial. It is well known, that fire damp explodes on ignition by an electric spark; and on this principle it is proposed, that an experiment be made with an apparatus consisting of Professor Daniel's voltaic battery and electrical wires, for the purpose of firing the gallery of a mine charged with an explosive mixture. By means of this ingenious and scientific contrivance, an explosion of fire damp can at all times be effected with perfect safety, whenever the gas is evolved in sufficient quantities to generate this destructive element; and as the wires can be conveyed to the remotest chamber of the mine at a trifling cost, the experiment may be repeated with great facility by the aid of a powerful battery, in any place where it indicates its appearance, or creates a suspicion of danger. The actual presence, quantity, and position of the fire damp, can always be ascertained with precision and certainty, through the agency of the safety lamp; but care must be taken that the carbonic acid and azote remaining in the mine after the inflammation, be got rid of, either by decomposition, absorption, or ventilation, before the workmen resume their labours. This formidable and treacherous enemy will thus be effectually and instantaneously annihilated, that

otherwise could be but slowly, partially, and progressively consumed, combined with the advantage, that the health of the miners will cease to be impaired from respiration in a foul atmosphere.

Athenæum.

## Progress of Physical Science.

*Experiments and Observations on the Temperature of Artesian Springs or Wells, in Mid-Lothian, Stirlingshire, and Clackmannanshire.* By ROBERT PATERSON, M. D., M. W. S. Communicated by the Author.\*

Coal being the object of most general search amongst proprietors in this country, its presence has been long ascertained by making perforations into these strata. In the course of these borings, it frequently happens that, after passing through a series of layers which are impervious to water, they come upon one from which it exudes abundantly, occasionally spouting to a considerable height from the mouth of the bore.

Thus, in an instance which Mr. Johnston of Meadow Bank, near Falkirk, has been kind enough to communicate to me, upon boring to the depth of 414 feet from the bottom of one of his coal-pits, the rush of water was so great as nearly to inundate the pit, and was with great difficulty stopped for a time by inserting a wooden plug into the mouth of the bore. This, however, also proved insufficient, the plug being expelled with great force by the upward pressure of the water. The number of these springs throughout Scotland is now considerable, and, since public attention has been turned to them by M. Arago† and others, and more especially to the fact that they are the surest means of deducing the rate of increase of the internal temperature of the earth, they possess an additional interest.

If the water, as it makes its exit from the mouth of a bored well, possesses a temperature above that of the surrounding atmosphere, it must have acquired that temperature from the rock out of which it came. But two very important objections have been urged against its possessing precisely the same temperature as the rock which contained it. *First*, That frequently springs coming from a higher level mix, and consequently modify the temperature of the water. *Second*, That water coming from a great depth, loses a certain degree of its temperature in imparting it to the cooler sides of the perforation.

That such objections might not be brought against this species of information, we used an instrument which has been long known for ascertaining the temperature of water at great depths. It consists of a glass-tube with brass ends which screw on; in each of these ends there is placed a valve, and both of the valves open upwards. It contains a thermometer, and is surrounded with a non-conductor; a string being attached to it, it is lowered down into the bored well. The water rushing up the bore, together with the instrument descending against it, causes both valves of the instrument to open, by which a free communication through the instrument by the valves is kept up, until it reaches the bottom of the perforation. The instrument is to be allowed to remain there for a short time, and then withdrawn as quickly as possible. As soon as we begin to withdraw this instrument, the valves close, and consequently include a quantity of water from the lowest level, at which it has been.

\* Read before the Wernerian Natural History Society, Jan. 12th, 1839.

† See Professor Jameson's Journal, vols. i. xviii. xix. xxiii. xxiv.

We have used the above described instrument on many different occasions, and in many different artesian wells, both those of recent and of several years formation, and on no occasion did we find the slightest difference of temperature, between the water taken at the mouth of the bore, and that brought up by the instrument.

In all springs, therefore, of this description, in which we can tell the depth from which the water comes, we may safely rely upon the temperature of the water at the mouth of the bore being similar to that at the bottom of it, and consequently of the stratum from which it came. And, in those instances in which we have reason to suspect that the water is mixed with springs from a higher level, the use of an instrument similar to that above described will settle the question.

Our first experiment was made on an artesian spring in the immediate neighbourhood of Edinburgh. When the brewery at Meadowbank (the place to which we refer) was erected, a well was sunk to about forty feet from the surface, for the purpose of supplying the establishment with water; in consequence, however, of the supply proving deficient, the proprietors were recommended to sink a bore from the bottom of the well. This was accordingly done through different coloured clays, sands, and very thin strata of fragile sandstone, to the depth of 119 feet, till they reached a considerably thicker and firmer stratum of sandstone, from which the water filled the bore and gushed over its edges. The supply has since continued, and proves amply sufficient for the great consumption of the brewery.

The well into which the water of this bore is allowed to enter is soon filled, in consequence of the large quantity of water emitted by the artesian spring. It will, therefore, be obvious that opportunities of testing the temperature of water, at the mouth of the bore itself, do not often occur. Through the kindness of Mr. Aitken, however, I was enabled to do this, and found the temperature of the water to be  $49\frac{1}{2}^{\circ}$ , and which temperature, of course, would have been the same had it come to the top of the well. This well, as we have already stated, is 40 feet deep, therefore the temperature of this water was that of the rock 159 feet below the surface.

[After describing a number of wells with some account of the various strata bored through, the author proceeds:] We may remark that artesian wells are abundantly to be found throughout the rocks of the coal-formation. This is a fact not at all to be wondered at when we consider the variety of rocks which are to be found in that series, some of which are pervious, and others impervious, to water. Indeed, so well is this known in some parts of the country, that preparations have always to be made before commencing a perforation, so that they may be enabled to stop the flow of water from it, in consequence of the water proving a nuisance to the land in the immediate neighbourhood, if it is not wanted for economical purposes.

The quantity of the water which flows up these perforations is very various, generally bearing a proportion to the width of the bore, and the depth to which it is carried. In some of those which we have mentioned, the quantity of water is very considerable, coming out of a bore nearly three inches in diameter, in a full and continuous stream; and I am informed by Mr. Johnston of Meadowbank, who continued boring to the depth of 69 fathoms (414 feet) from the bottom of one of his coal-pits, that at that depth the rush of water was so great that they were obliged to stop the boring operations. The quantity of water ejected by this bore has been roughly calculated by Mr. Johnston, to be about a hogshead per minute. The



quality of the water is excellent, and is used by many families in the neighbourhood of these perforations in preference to the surface springs. It, in general, contains a quantity of the hydrate of iron, received probably from the strata of ironstone through which it has to pass; this however, is soon deposited by the water in the shape of a hydrated oxide, on the bottom of the water-course. In some instances, however, the quantity of iron is so great as to constitute it a slightly chalybeate spring.

It is a curious fact connected with the artesian springs of Clackmannanshire, that some of them, and more especially those of least depth, emit a much larger quantity of water when the tide is high. This is a remark which has been made by Mr. Bald, and by various individuals in their neighbourhood. It is very evident that this increase in the quantity of the water given out by the spring, has a connexion with the rise of the tide, and has been most commonly, and in our opinion very properly, referred to fissures extending into the strata, and to which the sea-water has access. That no salt water can extend along these fissures is proved by the fact, that these artesian wells are never brackish; but to account for this, it has been supposed that the percolation through the strata is sufficient to remove the salt; this, however, cannot be, as no percolation which we are yet acquainted with, enables us to remove the saline ingredients of sea-water. We are, therefore, inclined rather to explain it after the following manner:—These fissures extend, as we have formerly mentioned, through the strata into the bed of the river; these, however, are constantly discharging water into the river, the quantity of which, however, must materially vary according to the superincumbent pressure. Thus, when the tide is high, the quantity emitted by the fissure into the river must be considerably less than when there is only a small quantity of water in the river. Now, if there is a constant discharge of fresh water from this fissure, we can easily understand that, according to the laws of hydrostatic pressure, the quantity emitted by the artesian spring when the tide is high, is just so much greater as the quantity of water emitted by the fissure into the river is less. This, it appears to us, will sufficiently explain the phenomenon, without the supposition that percolation, or any other process, removes the saline taste of the sea-water.\*

We now come to consider the increased temperature which these artesian wells are found to possess.

When we look at the experiments which have been related in a former part of this paper, we cannot but be struck with the similarity of the results, as deduced from localities far different from each other; such a result cannot be accidental, and cannot be explained by causes of a local nature, but must be produced by some general agency, which extends over the whole surface of the globe, and which is now believed by the generality of geologists to be the central heat of the earth.

It was long ago advanced by M. Arago, that Artesian wells were the only sure way of arriving at any correct data by which to judge of the increase of temperature as we descend in the crust of the earth. The temperature of mines had previously been much attended to, but the results were found so various, and the sources of fallacy so numerous, that no cor-

\* There are natural artesian wells (springs) of excellent fresh water on the borders of some of our salt marshes. It would be interesting to ascertain whether the flow of water from them is affected by the tide, and to what extent, and also whether the depth of water in wells near the sea coast varies in many instances with the tides. Communications on the subject will find acceptance in our pages. G.

rect data could be based upon them with any confidence. In reviewing our experiments, it will be obvious that they bear upon two very important topics connected with this subject, and these are, *first*, the rate of increase as we descend, and *secondly*, the regular ratio which it bears.

This latter point is distinctly shewn by observing the temperature of artesian wells of small depth, and comparing them with those of great depth. Indeed, so much can this be depended on (at least in the districts we have examined,) that on several occasions when individuals totally unacquainted with the subject have been told the mean of the district, and the usual rate of increase which had been found in other springs in that neighbourhood, as well as the depth of the spring we were about to examine, they have told the temperature very nearly.

The use, too, of the instrument before mentioned, renders our calculations upon the regularity of the increase very satisfactory.

We shall subjoin, in a tabular form, the result of our experiments on the temperature of the artesian wells, and the rate of increase as we descend.

*List of the Localities, Temperature, and Rate of Increase of the Artesian Springs, mentioned in the present communication.*

| Name of place.                                         | Temp. of Spring. | Temp. of District. | Depth of Spring. | Rate of increase. |              |
|--------------------------------------------------------|------------------|--------------------|------------------|-------------------|--------------|
|                                                        | °                | °                  | Feet.            |                   | Feet.        |
| Meadowbank . . . . .                                   | 49½              | 46½                | 159              | 1                 | for every 53 |
| Kerse . . . . .                                        | 51½              | 46                 | 231              | 1                 | “ 42         |
| Mumrills . . . . .                                     | 51               | 46                 | 213              | 1                 | “ 42.7       |
| Loanside . . . . .                                     | 48               | 46                 | 100              | 1                 | “ 50         |
| Kennetpans Distillery Bore .                           | 51½              | 46                 | 270              | 1                 | “ 49.1       |
| Spring immediately under Mr. Bruce of Kennet's house } | 53               | 46                 | 350              | 1                 | “ 50         |
| The 4 springs here noted are }                         | 51               | 46                 | 210              | 1                 | “ 42         |
| in the immediate neighbour- }                          | 49               | 46                 | 160              | 1                 | “ 53.1       |
| hood of Kennetpans, and }                              | 50¾              | 46                 | 200              | 1                 | “ 42.6       |
| quite close to the roadside. }                         | 51               | 46                 | 210*             | 1                 | “ 42         |
| Parish of Slamannant . . . .                           | 48               | 45                 | 180              | 1                 | “ 60         |
|                                                        |                  |                    | Average          | 1 for every 47.11 |              |

A simple inspection of this table will shew how very nearly the results of different localities approximate; and if we take the average number of these results, 1° for every 48 feet as we descend, we shall find that it comes very near the average, as fixed upon by the British Association, which is 1° for every 45 feet of depth. On comparing this table with the following, which has been drawn up from a variety of sources, but more especially from papers which are to be found in Professor Jameson's Journal, we shall find that the average of the former is much less than the latter, and this chiefly in consequence of some of the observations we have quoted having been made on enclosed waters at the bottom of old pits. We have altogether

\* This is the supposed depth; accurate information regarding it could not be procured.

† Mr. Kincaid has furnished me with this observation, on which perfect reliance can be placed.

kept out of the experiments of Spasky and Kupffer on the artesian wells of Vienna, as there is certainly some mistake, or rather, as Professor Bischof remarks, some militating cause, and he conjectures "that the depths of these springs are not equal to the lowest point of the course of the spring, but that the springs rise from a still greater depth."

|                                                                                           | °            | Feet.            |
|-------------------------------------------------------------------------------------------|--------------|------------------|
| Rüdersdorf (Magnus and Erman,)                                                            | 1 in every   | 48.3             |
| Later observations,                                                                       | 1 "          | 51.2             |
| Still more recent,                                                                        | 1 "          | 54.1             |
| * { Erzgebirge (Bischof,) from observations on enclosed waters,                           | 1 "          | 61.8             |
| Monk Wearmouth,                                                                           | 1 "          | 59.7             |
| Cornwall, from springs,                                                                   | 1 "          | 54.8             |
| Cornwall, from enclosed waters,                                                           | 1 "          | 52.7             |
| Uralian Mountains, from a comparison of the most authentic observations in these regions, | 1 "          | 55.4             |
| Rüdersdorf, from rising springs,                                                          | 1 "          | 54.4             |
| Paris, Well at Port St. Ouen,                                                             | 1 "          | 72.1             |
| Departments du Nord, { Well of Marquette,                                                 | 1 "          | 61.              |
| et du Pas de Calais, { Aire,                                                              | 1 "          | 41.              |
|                                                                                           | St. Vincent, | 47.              |
| Sheerness,                                                                                | 1 "          | 41.              |
| Tours,                                                                                    | 1 "          | 41.8             |
| Geneva, (De la Rive et Marcet,)                                                           | 1 "          | 50.              |
| Paris, Slaughterhouse of Grenelle,                                                        | 1 "          | 57.1             |
| Average,                                                                                  |              | 1 for every 53.1 |
| Edinburgh New Philosophical Journal.                                                      |              |                  |

*On the Cause of the Holes that occur perforating sheets of Melting Ice. A Prize Essay in the Chemical Class, Marischal College, Aberdeen, Session 1837-8. By JOHN FERGUSON, of Nigg, Student of Medicine.*

The holes in question are generally about one or two inches, and sometimes more, in diameter. In shape, they are more or less round, but seldom completely cylindrical. In direction, they are most commonly perpendicular to the surface of the ice. After a thaw, they may be readily seen in the sheets of melting ice that float down a river, or on the sea-shore near its mouth. They occur not only in very thin sheets of ice, but in ice upwards of three inches in thickness; and not only in ice disintegrated by melting into a porous texture, but in ice apparently the most compact.

In order to ascertain the cause of these holes, the structure of ice was first considered. Depressions, especially in the under surface of ice, may be observed, and, at such depressions, it may be supposed that the ice will melt into holes; and this in fact happens. But the holes thus formed are seen only in ice less than half an inch in thickness, they are bounded by thin sharp edges, and they are seldom round, so that they do not at all resemble those that are the object of the present inquiry.

Air cells, which are to be found in all ice, varying greatly in their size and frequency in different pieces, but in both respects very equally distributed in the same piece, may also produce small holes in very thin ice;

\* Copied and reduced from Professor Bischof's paper on Thermal Springs.



but these are easily distinguished from the larger holes in question, which, as has already been mentioned, occur in ice, although thick, and whether porous or compact.

Ice, in freezing, has a tendency to assume a crystalline structure, which, were it to differ in any one part from the rest, might, in such part, occasion a corresponding facility in the melting. Yet no such difference was detected by inspecting newly frozen ice; and pure newly frozen ice was observed to melt by a warmer atmosphere, or by the sun, without forming any of the holes in question. Ice, indeed, while melting, sometimes appears to consist of a number of prisms laid loosely in apposition, and directed perpendicularly to the plane of the sheet. But I could never succeed in driving any one of these prisms through into a hole, without, at the same time, breaking the surrounding ice. Besides, the holes to be explained are not peculiar to ice of such structure.

As none of the circumstances attending the formation of ice seemed to account for the appearance of the holes in question, attention was next given to ice during the process of melting. After the formation of ice, indeed, and while hard frost continued, nothing rudimental of a hole could ever be observed. Thus the question came to be, What circumstance in the melting gave rise to the holes?

Their frequent occurrence in ice at the mouths of rivers might suggest the idea of their being dependent on salt water—a conjecture supported by the well-known effect of salt in lowering the freezing point of water, and its consequent power of melting ice. The holes, however, occur in inland pools, and in rivers at a distance of several miles from the sea. I froze sea-water by exposing it during a very cold night to radiation—the natural freezing agent. When the ice thus produced was melted, in almost every natural manner, none of the holes were formed, but only a spongy porous texture, in consequence of the rapid melting apart of almost all the ice impregnated with saline substances. I also immersed common ice in sea-water, where the melting took place more rapidly than in fresh of the same temperature, but, in other respects, little, if any, difference of action was observed. From these and similar considerations, I inferred that the formation of the round holes is little dependent on the presence of saline substances in considerable quantity—much less in the exceedingly minute quantities held in solution in ordinary fresh water.

The remarkable property of becoming specifically heavier, as it ascends in temperature from 32° F. to 38° F. belongs to water. On account of this property, water lying in a depression on the surface of a sheet of melting ice, would obviously undergo a circulation, the portion heated by the air descending in the centre, and, when cooled by ice at the bottom, rising by the sides. The immediate consequence of the warmer water being thus always conveyed to the bottom, would be to melt the ice at that part, and thus produce a hole. But when a depression was made in a sheet of ice, and water put into it, the depression, so far as I could observe, continued of the same depth during the whole time of melting. Hence, in such circumstances, the ice probably received the heat as fast as the water.

After having thus far failed to account for the appearance in question, I made an observation that indicated what seems to be the real cause.

In the course of my observations on ice melting on the sides of rivers, I frequently saw holes not entirely perforated through the ice. In the bottoms of these, I always observed solid bodies—stones, dust, sand, bark of trees, or the like. In one instance, of which I had taken particular notice,

I subsequently observed that the imperfect hole had been rendered complete, and corresponded in size to those, the cause of whose formation I had been attempting to discover. I then placed a stone above a piece of ice during sunshine, and examined it on the following day, when a complete hole, bigger than the stone, was found in the ice below the place where it had rested. I confirmed these observations by experiments repeated under varied circumstances, always with like results. Thus, having placed upon ice almost all such small bodies as are usually found on the sides of rivers, I exposed it, in order to melt, both in the rays of the sun and in a warm atmosphere. In all the experiments holes were produced. I have also seen, where two sheets of melting ice were lying, one above the other, a complete hole through the upper, and an incomplete one through the under sheet, continuing the upper hole, and having at the bottom a bit of clay. Under the same circumstances of temperature, holes were produced when the bodies were put below the ice, so as to allow it to rest on them; and when dust, crumbs of brown wood, and other such light substances, were placed below, they rose up, by capillary attraction, as the holes upwards approached the surface, always keeping the top of it, till the holes were completed. After exposure for one or two days, the holes produced in my experiments, as also those whose formation I had watched, were, by continued melting, ultimately smoothed into the same appearance as those for whose origin I had been seeking to account.

The principle on which these foreign bodies act in producing holes, is their possessing the property of absorbing radiated heat in a higher degree than ice. That this explanation may be applicable to cases in which the body has sunk so far into the ice as to be out of the reach of the direct rays of the sun, or has been originally below the ice, it is necessary that ice should give passage to the heat of the sun's rays. That ice has this property, was determined experimentally. I took a sheet of pretty transparent newly frozen ice, fully half an inch thick, and having smoothed the inequalities of its surfaces, I found that I could inflame a piece of sealing-wax, by concentrating on it the rays of the sun, by means of a burning glass, whether the ice was interposed between the sun and the lens, or between the lens and the wax. The effect, indeed, seemed to be little diminished by the interposition of the ice. Yet, that ice does not transmit heat altogether without interruption, appeared from the possibility of melting a hole in the most transparent ice by the same lens. Hence it appears that heat, radiated from the sun, will pass through ice, with little interruption, to any opaque foreign body, by which it will be absorbed, and by which it will be communicated, by conduction, to the contiguous ice.

The sun is evidently not the only source of the radiated heat absorbable by such foreign body. Thus, we can scarcely suppose that all the sun's heat is intercepted by the clouds, even in a day the most overcast, as such a circumstance never happens with his light; and, when ice is melting in a warm room, not only the fire, but the walls and furniture, are sources of radiant heat. The natural exposure appeared to be most favourable to the formation of the holes; for, in the rays of the sun, a sheet of ice, with a stone above it, was often entirely perforated before the sheet had melted a quarter of its thickness, while in a warm room, it would first have to melt nearly half its thickness. Perhaps the reason was, in part, the more equal action of the heat derived from the atmosphere by conduction, and, partly, the greater absorption by the ice of heat radiated from terrestrial objects, than of heat emanating from the sun.

The explanation of the form of the holes will now be easily understood. As the bodies that produce them, generally either are of themselves round or oval, like most of the small stones found on a river side, or are collected by the washing of the water into circular heaps, as in the case of sand, it is evident that the holes must, from the first, tend to assume a circular form. But, as an additional widening of the hole, during and after its formation, always takes place, owing to the continued melting of the ice, the first irregularities become ultimately less observable. The holes are seldom of equal width throughout, being sometimes wider above than below, at other times the reverse. The foreign body that forms the hole has originally descended, when the hole is wider above—the first formed part of the hole being widened by its longer subjection to the common melting that the whole sheet undergoes—and, in the reverse case, the body has been below the ice, and has ascended.

I have never observed any of the holes, not completely perforating the ice, without having at its bottom some opaque foreign body. The holes, during their formation, take a direction perpendicular to the horizon; and the occasional obliquity of the holes, in reference to the surface of the ice, is to be accounted for by their having been formed when the sheets lay in a position oblique to the horizon.

Before the breaking up of ice by a thaw, the holes most usually are to be observed at the sides of rivers. Indeed, I have scarce ever seen them in the middle. After the breaking up of ice by a thaw, several circumstances serve to increase the number of holes. On the sides of rivers, there is generally a collection of small round stones. Upon these, sheets of ice, when floated up by the rise of the tide, are left, and, during the thaw, soon become perforated with holes upwards. If such holes should not be complete at the time, they are rendered so by subsequent melting. As the stones, in such situations, frequently rise an inch above the surrounding level, they may perforate holes in ice an inch thick. The holes in ice of greater thickness, are commonly produced by bodies lying above the ice, such as the small stones that are washed upon the ice by the agitation of the water, or bits of bark, or of brown wood. Such light bodies, when they float, sometimes produce holes upwards, by being placed below the ice. Holes break out, also, wherever light bodies have been frozen into ice, as occurs in almost every situation. Collections of sand, earth, or clay, constitute another very usual cause of holes.

Standing waters afford peculiar occasion for foreign solids to produce holes in its ice. In a pool, where small single blades of grass had been frozen into ice of two or three inches thickness, I have observed that, during a thaw, the ice immediately surrounding the grass melted into a round hole, often an inch or two wide; and, in ice upwards of three inches thick, where a few withered rushes—one here, one there—were frozen, in a horizontal position, in the middle of the ice, every rush, after a few days' thaw, had a space around it, large enough to hold ten rushes. The vital heat of the grass may have contributed to the melting; but the dead rushes could only have acted like any other opaque inorganic solid.

Holes of a similar origin to those in ice, accounted for in this Essay, occur also in melting snow, where dust, or other opaque solid has lain on the surface.

L. & E. Philos. Mag.



NOTICE FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

*Whether plants acquire Azote from the Atmosphere.* By M. BOUSSINGAULT.

I shall examine in this second memoir, whether plants, which are fully developed, and endowed with a complete organization, assimilate azote when transplanted and cultivated in a soil absolutely deprived of organic matter.

The experiments that I made last year prove that clover, sprouted, (né) and cultivated in sand previously calcined, admits, in its organization, a certain quantity of azote, derived, very probably, from the atmosphere. I this year raised peas under similar circumstances, and obtained the same results; and proved what was rather an unexpected fact, that peas under the influence of this regimen, having no other aliment then water and air, will bloom and bring their fruit to perfect maturity.

Five peas, weighing together 1.211 grammes, and each having the same weight, were sown on the 9th of May, in clay previously calcined to redness and then moistened with distilled water. They were placed in a closed pavilion, and with the precaution of preventing the access of any dust that might be floating in the atmosphere. On the 16th of July they had a fine appearance, were in blossom, every pea producing a stalk and each stalk a flower. On the 15th of August the pods were ripe. We then ceased to water them, and at the end of the month the plants had become dry. The length of the stalk was from one to one and a quarter yard, but very slender, and the leaves were but about one-third the size of those raised in a manured soil. The pods were about one and a quarter inch long and nearly half an inch wide. Four of the pods had each two peas in it; the fifth but one, but its size was nearly double that of the others.

The composition of the peas, after being dried in a vacuum of 110° (= 230° F.) was:—

|             |   |   |       |
|-------------|---|---|-------|
| Carbon,     | . | . | 53.5  |
| Hydrogen, . | . | . | 6.6   |
| Oxygen,     | . | . | 33.8  |
| Azote,      | . | . | 3.5   |
| Ashes,      | . | . | 2.6   |
|             |   |   | <hr/> |
|             |   |   | 100.0 |

The stems and pods dried in the same manner (the ashes being deducted) contained,

|           |   |   |       |
|-----------|---|---|-------|
| Carbon,   | . | . | 52.8  |
| Hydrogen, | . | . | 6.2   |
| Oxygen,   | . | . | 39.4  |
| Azote,    | . | . | 1.6   |
|           |   |   | <hr/> |
|           |   |   | 100.0 |

The result of the experiment was:

|              | Grammes. | Carbon.            | Hydrogen. | Oxygen. | Azote. |
|--------------|----------|--------------------|-----------|---------|--------|
| Peas planted | 1.072    | containing 0.515   | 0.069     | 0.443   | 0.046  |
| Produce      | 4.441    | containing 2.376   | 0.284     | 1.680   | 0.101  |
|              |          | <hr/>              | <hr/>     | <hr/>   | <hr/>  |
|              |          | Difference + 1.861 | + 0.215   | + 1.237 | + .055 |

Hence 1.072 grammes of peas gained 5.369 grammes of organic matter in ninety-nine days of growth during the warmest months of the year; and we find that the azote in the seeds sown was more than doubled in the produce.

2. From a field of clover sown in the preceding year, the author selected several plants of the same height. The adhering earth was removed from the roots by careful washing in a fine stream of water; the plants were then dried by pressing them with blotting paper and by exposure to the air during several days. Three of them were retained for analysis, and three others were immediately planted in sand recently calcined and moistened with distilled water, and placed so as to be sheltered from dust. They at first languished, but soon afterwards became remarkably vigorous. In the course of a month their height was doubled; the leaves had a good colour, and they appeared as well as those of the plants which grew in the open field. About the 8th of July the flower began to appear, and by the 15th had assumed a flesh colour. The watering was discontinued on the 1st of August that the plants might dry.

The roots were very little extended, their extremities were very hairy, but the knotty portion which constitutes the body of the root had made no progress. The plants were gathered, cleaned, dried, reduced to powder and analysed in the same manner as were the peas.

The author afterwards treated several plants of oats in the same cautious manner, and we thus sum up the results of his experiments.

1. Peas planted in a soil absolutely sterile and watered with pure water, acquire complete development, pass through all the phases of vegetation, and produce fruit perfectly mature. Azote constitutes one of the aliments derived either from the water or the air, and assimilated by the plant.

2. Clover taken from a fertile soil, and afterwards cultivated without the presence of dead organic matter, likewise gained an accession of azote.

3. Oats taken from a manured soil and placed in the same condition as the clover, acquired from the air, carbon, hydrogen, and oxygen without assimilating any azote; the analysis, on the contrary, indicating a slight loss of that principle.

The researches I have undertaken appear then to prove that under various conditions certain plants are disposed to derive azote from the atmosphere. But in what circumstances, and in what state azote becomes fixed in vegetables, is a question which we are yet unable to decide.

In fact, azote may enter directly into the organism of plants, if their green vessels are adapted to its combination; or it may become a constituent in them, through the water which always contains air and which is inspired through the roots. Finally it is possible, as many philosophers are of opinion, that there exists in the air an infinitely small quantity of ammoniacal vapour.

*Annals de Chem.*, Dec., 1838.

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*Geology of the Moon.*

Capt. Portlock, President of the Geological Society of Dublin, being of opinion that information as to the original condition of the surface of the earth might be obtained by an inquiry into the condition of some other planetary body, wrote to Dr. Robinson, of Armagh, on the subject; the following is the Doctor's interesting reply:—

*Observatory, Armagh, Feb. 7, 1839.*

MY DEAR SIR,—My general notion is, that you are quite right in refer-

ring to the moon as evidence of the absence of weathering. The sharpness of its rocks and peaks is quite surprising; for every angle and edge stick out with a ruggedness that is, perhaps, the thing which first strikes an observer with a sense of the wide difference between that globe and the earth. It alone would show that air and water are absent, had we no other evidence. But you are, I think, in error, when you infer from the great height of lunar mountains, the probable quantity of the wearing down which our earthly peaks have suffered. The moon has less attractive force than belongs to our planet, so that the same elevating force would do about twenty times as much work; and there is every reason to believe that the elevating forces were far more energetic. Indeed, I regard the appearance of the moon as strong presumption against Mr. Lyell's notion, that the energy of volcanic action is as powerful now as it was in the primeval epochs of our planet. No volcanic action is now at work in the moon; but we see that it was once raging with uncontrollable fury, and on the most prodigious scale. There it has actually worn itself out; here, I think, we may assume that it has merely expended most of its force. I may here tell you some of the matter which I see, or think I see, on the surface of our satellite. The mountains of earthy shape are some pretty high, the highest peak of the said Apennines being, according to the best authority, something under 17,000 feet above the plains from which it rises; but this is a rare instance, and very few reach 6000. They are of astonishing steepness. But the Ring mountains, or craters, are much stranger affairs. Take, for instance, Tycho, that bright spot in the south-east quarter, from which the rays seem to run. It is fifty miles in diameter, and 16,000 feet deep, surrounded by broad terraces within, and with a central mountain about 5000 feet high.



This is the type of the principal part of the lunar mountains; some are 200 miles diameter, and one nearly of this latter size, 22,000 feet deep. What a paroxysm it must have been that hollowed out this monstrous crater. Observe that all these craters are depressed below the lunar surface, the elevation of their walls above it being in general but half their depth below it; and the question is, what becomes of the immense quantity of materials that must have been blown out of them. Schroeter thought that the walls, if demolished, would fill the cavities; but this (in Tycho, for instance) is certainly not always the case, and we do not recognise heaps of debris in the vicinity. But we do find a curious appearance sometimes—those rays to which I have already alluded as diverging from particular craters. They are peculiarly bright, but not at all elevated above the lunar surface, and give the idea of a fluid which had run out in currents, and produced some chemical change in the soil over which it passed. As these rays are themselves bristled with craters, these latter must have been of subsequent formation. The long lines terminating in those dusky places, which we sometimes hear called seas, have perchance been rivers; but as they generally seem to originate in some crater they were more probably the track of volcanic fluids, which, however, must have been quite different from our lava, and, perhaps, have played some part in the absorption of the lunar at-



mosphere, and the removal of its seas. In general the large craters are far more brilliant than the other parts of the moon, and the comparative obscurity of the seas arises from the scarcity of volcanic action there. On earth, I believe, our present volcanic products are but little reflective; it is otherwise there; but it may be remarked, that the small craters, which subsequently broke out on the greater and older ones, are much less bright, as if the expiring action had been more analogous to that of our own planet. But this at least is clear, that since the invention of the telescope the moon has been undisturbed. But I must stop by assuring you that I am yours sincerely.

T. R. ROBINSON.  
Mining Jour.

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## Mechanics' Register.

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### *The Daguerreotype.*

A curious application of the Daguerreotype, is to be made at the opening of the railroad to Courtrai, Belgium, if the weather be favourable. The camera obscura is to be placed on an eminence commanding the royal pavilion, the locomotive engine, the train of wagons, and the major part of the *cortège*, and is to be brought into action exactly at the time of the delivery of the inauguration speech. A discharge of cannon is to be the signal for a general immobility, which is to last the seven minutes necessary for obtaining a good representation of all the personages present. The plate is afterwards to be enclosed in lead and deposited under the first stone of the foundation of the station at Courtrai.

Mining Jour.

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### *Elkington's Patent Mode of Gilding by Immersion.*

The ordinary gilding process is well known. An amalgam is formed by rubbing together gold in a comminuted state, and quicksilver. With this amalgam the article to be gilt is covered, and being then exposed to heat, the mercury exhales, and the pellicle of gold remains. The mercurial vapour is condensed, and, thus recovered, is again and again applied to use. By the new process, the gold is dissolved in what the older chemists used to denominate *aqua regia*, with which is mixed one of the combinations of potash. The solution is heated, in order, we suppose, that it may suspend a greater quantity of metal than it would do if cold. At the model room a small spirit lamp was used for the purpose. The copper, or other article, is cleaned by successive washings in acids of diminishing strength, and, lastly, in pure water; it is then dipped in the saturated solution for a few seconds, again washed, as before, and in half a minute the entire process is over, and it is presented to the spectator, beautifully gilt. The gold is deposited on the same principle that crystals shoot upon a rod or string. For single gilding one dipping is required, when a thicker coat is necessary, the dipping and rinsing is repeated.

Lond. Mech. Mag.

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### *The Italian Scientific Association: Meeting at Pisa, October 1st to 15th, 1839.*

All the members of the Italian Scientific Association are admitted to the privileges of membership without any pecuniary payment. An open field is granted to them in the sectional meetings of the Association for the com-

munication of their discoveries and observations, constant opportunities are afforded for the encouragement of conversation, and a tribute of respect is paid to a large portion of the members, by the formation of a select society, within the Association, consisting of those individuals who have worked for the advancement of science, and including, at the same time, the members of distinguished scientific societies.

Great praise is due to Prince Charles Bonaparte, aided by several eminent Professors of Pisa and Florence, for their exertions in originating the Italian Scientific Association. These philosophers were fortunate in obtaining the zealous co-operation of Leopold II, the Grand Duke of Tuscany, in the preliminary arrangements for the meeting; and the attendance of that sovereign at the sectional meetings of the Association, and his willing attention bestowed on the scientific papers which were read in the various sections, plainly demonstrated the interest which he felt in the proceedings of this society.

On the 1st October, 1839, a religious service was performed in the cathedral at Pisa, to which the Catholic members of the Association were invited. After this service, an introductory meeting of the scientific members was held in the university. On the following day, a beautiful marble statue of Galileo, which had been recently erected in the centre of the court of the university, was exhibited to the members of the Association, and a formal oration was delivered by Professor Rosini of Pisa in honour of Galileo.

The first general meeting of the Italian Association took place on the 3rd of October, and Professor Gerbi, the aged President of the Association, read a long address on this occasion, in which he expatiated largely on the praises of Galileo, and detailed some of the principal advantages of the six sections of the Association. Several letters from the absent friends of the Association were also read at the same meeting, and among these letters, one of the most interesting was from Sir John Herschel.

All the sections were well attended, and the audience appeared interested, and at times greatly delighted, especially during the most animated discussions.

A magnificent dinner was given by the Grand Duke of Tuscany to all the scientific members of the Association on the 10th of October, and about three hundred philosophers sat down to this banquet, at which the Governor of the city of Pisa presided. After dinner, the health of Leopold II, the Grand Duke, was drunk with evident gratification, and verses were recited in well-merited praise of his liberality.

On the 14th of October, the sectional meetings terminated, and on the 15th of October, the last general meeting of the Association was held, when the Grand Duke of Tuscany took his seat at the right hand of the President. Reports were read from each of the sections; the laws of the Association, drawn up by the committee of the presidents of the sections, which formed the governing body of the Association, were declared; and it was announced that the next meeting of the Italian Association would be held, in 1840, at Turin, and that the meeting in the following year, 1841, would take place at Florence.

L. & E. Philos. Mag.

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### *Eccaleobion, or Machine for Hatching Eggs.*

Proceedings of the Zoological Society.

June 11, 1839.—Mr. Bucknell exhibited his *Eccaleobion*, or machine for hatching eggs; and having broken eggs in every stage of incubation, explain-

ed the nature and incidents of the process. Mr. Bucknell stated that the period of incubation in the common fowl, which was, on an average, 21 days, sometimes varied from 18 to 24 days, and that he attributed this variation to the mode of keeping, and previous treatment, by which the embryo was injured, either from the heat of the weather, exposure to variety of temperature, jolting in carriage, &c. The young bird was occasionally known to emit a faint chirp even so long as 24 hours before being excluded; and he believed that if this noise was heard on the 18th day the chicken would probably appear on the 19th. From this and other circumstances, such as the common mode of preparing eggs by varnishing, &c., the porosity of the shell, and other similar causes, he concluded that the small globule of air constantly found in eggs, and which he had observed to increase according to the age of the egg, was produced by the air penetrating the substance of the shell and its lining membrane.

The average number of malformations, according to Mr. Bucknell's experience, was not more than five in a thousand; though in Egypt, it was stated, malformations were extremely common in the artificial process of incubation. He attributed this circumstance to an excess of heat, and generally found it to affect the toes and extremities; sometimes also the muscles of the neck.

Ibid.

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### *Microscopical Investigations.*

A Society has been formed in London designated the "Microscopical Society." Its objects are, to promote improvements in the optical and mechanical construction of microscopes; the reading and discussion of papers, upon new and interesting subjects of microscopical enquiry; the formation of a collection of rare and valuable microscopical objects; and of a library of reference. At the close of the business of the evening, upwards of fifty gentlemen joined the society. The terms upon which members are admitted, are one guinea entrance, and a yearly subscription to the same amount.

Mag. Nat. Hist.

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### Notice.

*Proposed exchange of Minerals.*—The subscriber has recently made a large collection of the minerals of Nova Scotia, formerly discovered by Dr. Jackson and himself, and is desirous of exchanging suits of them for the minerals of other regions, foreign or domestic. The specimens have been selected with great care, are of good size, and generally well crystalized, often uniting in the same specimen several different species. They comprise nearly all the species of the Kouphine spars of Mohs and Haidinger; rhomboidal or uncleavable quartz; most of the varieties of quartz, agate, jasper, amethyst, &c., besides many interesting ores, salts of lime, &c. &c. By referring to the 14th and 15th volumes of Silliman's Journal, or to the 1st volume, new series, of the Transactions of the American Academy, a particular notice of these minerals will be found, in a memoir on the Geology and Mineralogy of Nova Scotia.

Those persons who may wish to exchange are requested to forward to the subscriber, in Boston, a list of such minerals as they may wish to dispose of, before sending the specimens, as his cabinet is already well supplied, and it is his wish to select such, principally, as are not already contained in it.

FRANCIS ALGER.

Boston, Mass., February 1st, 1840.



LUNAR OCCULTATIONS FOR PHILADELPHIA,  
JUNE, 1840.

Angles reckoned to the right or westward round the circle, as seen in an Inverting telescope.

☞ For direct vision add  $180^\circ$  ☞

| Day. | H'r. | Min. | Star's name.                                 | Mag. | From Moon's<br>North point. | From Moon's<br>Vertex. |
|------|------|------|----------------------------------------------|------|-----------------------------|------------------------|
| 6    | 10   | 9    | Im. q Leonis                                 | 5, 6 | 37°                         | 84°                    |
| 6    | 11   | 10   | Em.                                          |      | 257                         | 307                    |
| 6    | 11   | 22   | Im. 76 Leonis                                | 6    | 12                          | 62                     |
| 6    | 12   | 4    | Em.                                          |      | 286                         | 336                    |
| 9    | 11   | 33   | N. App. ♃ and 75 Virginis 6, ♃ North<br>2'.0 |      |                             |                        |
| 17   | 13   | 12   | Im. f Capricorni                             | 6    | 83                          | 65                     |
| 17   | 14   | 27   | Em.                                          |      | 329                         | 328                    |
| 18   | 12   | 55   | Im. r Capricorni                             | 6    | 110                         | 82                     |
| 18   | 14   | 19   | Em.                                          |      | 306                         | 292                    |

*Meteorological Observations for January, 1840.*

| Moon. |    | Therm.       |            |              |           | Barometer. |           | Wind.              |  | Water                          | State of the weather, and<br>Remarks. |
|-------|----|--------------|------------|--------------|-----------|------------|-----------|--------------------|--|--------------------------------|---------------------------------------|
| Days  |    | Sun<br>rise. | (2<br>P.M. | Sun<br>ries. | 2<br>P.M. | Direction. | Force.    | fallen in<br>rain. |  |                                |                                       |
|       |    |              |            | Inch's       | Inch's    |            |           | Inches.            |  |                                |                                       |
|       | 1  | 12           | 15         | 30.00        | 30.00     | NW.        | Moderate. |                    |  | Cloudy—clear.                  |                                       |
| ⊗     | 2  | 6            | 18         | .00          | .00       | W.         | do.       |                    |  | Clear—do.                      |                                       |
|       | 3  | 9            | 20         | 29.85        | 29.90     | W.         | do.       |                    |  | Partially cloudy—clear.        |                                       |
|       | 4  | 16           | 26         | .90          | .92       | W.         | do.       |                    |  | Partially cloudy—do. do.       |                                       |
|       | 5  | 13           | 27         | .94          | .94       | W.         | do.       |                    |  | Clear—do.                      |                                       |
|       | 6  | 23           | 33         | .94          | .94       | W.         | do.       | .06                |  | Cloudy—do.                     |                                       |
|       | 7  | 23           | 31         | 30.00        | 30.03     | E.         | do.       |                    |  | Snow—Clear.                    |                                       |
|       | 8  | 18           | 33         | .00          | .00       | W.         | Calm.     |                    |  | Lightly cloudy—do. do.         |                                       |
|       | 9  | 24           | 35         | .00          | 29.95     | W.         | do.       |                    |  | Clear—do.                      |                                       |
|       | 10 | 22           | 37         | 29.85        | .83       | W.         | do.       |                    |  | Clear—do.                      |                                       |
| ☾     | 11 | 30           | 40         | .80          | .76       | S.E.       | Moderate. |                    |  | Cloudy—do.                     |                                       |
|       | 12 | 19           | 21         | .90          | 30.10     | N.E.       | do.       | .04                |  | Snow—clear.                    |                                       |
|       | 13 | 18           | 31         | 30.00        | 23.87     | W.         | do.       |                    |  | Snow—cloudy.                   |                                       |
|       | 14 | 29           | 37         | 29.75        | .65       | W.         | do.       | .01                |  | Cloudy—do.                     |                                       |
|       | 15 | 31           | 27         | .55          | .60       | W.         | do.       |                    |  | Cloudy—snow.                   |                                       |
|       | 16 | 7            | 12         | .80          | .90       | W.         | do.       |                    |  | Clear—do.                      |                                       |
| ☼     | 17 | 1            | 11         | 30.05        | 30.05     | W.         | do.       |                    |  | Clear—do.                      |                                       |
|       | 18 | 6            | 17         | .05          | .05       | W.         | do.       |                    |  | Clear—do.                      |                                       |
|       | 19 | 10           | 22         | .15          | .03       | W.         | Brisk.    |                    |  | Clear—do.                      |                                       |
|       | 20 | 19           | 39         | 29.95        | 29.95     | W.         | Moderate. |                    |  | Clear—do.                      |                                       |
|       | 21 | 30           | 42         | .80          | .93       | W.         | do.       | .97                |  | Cloudy—do.                     |                                       |
|       | 22 | 30           | 33         | .90          | .80       | E.         | do.       |                    |  | Snow—rain.                     |                                       |
|       | 23 | 33           | 32         | .20          | .43       | W.         | Brisk.    |                    |  | Clear—do.                      |                                       |
|       | 24 | 14           | 20         | .95          | 30.00     | W.         | do.       |                    |  | Clear—do.                      |                                       |
| ☾     | 25 | 10           | 29         | 30.18        | .30       | W.         | Moderate. |                    |  | Clear—do.                      |                                       |
|       | 26 | 9            | 19         | .45          | .45       | W.         | do.       |                    |  | Clear—do.                      |                                       |
|       | 27 | 23           | 30         | 29.80        | 29.80     | S.E.W.     | do.       |                    |  | Cloudy—do.                     |                                       |
|       | 28 | 24           | 30         | .60          | .60       | E.         | do.       | .14                |  | Snow—cloudy.                   |                                       |
|       | 29 | 30           | 37         | 30.00        | .86       | E.         | do.       |                    |  | Drizzle—do.                    |                                       |
|       | 30 | 40           | 43         | 29.50        | .40       | S.         | do.       |                    |  | Rain—cloudy.                   |                                       |
|       | 31 | 27           | 29         | .95          | 30.00     | W.         | do.       |                    |  | Clear—Partially cloudy—aurora. |                                       |
| Mean  |    | 20.32        | 28.23      | 29.91        | 29.90     |            |           | 1.20               |  |                                |                                       |

| Thermometer.                                    |        |          | Barometer.                |
|-------------------------------------------------|--------|----------|---------------------------|
| Maximum height during the month.                | 49.00  | on 30th. | 30.45 on the 20th.        |
| Minimum                   "                   " | 1.00   | 17th.    | 29.20       "       23rd. |
| Mean                                            | 24.23. |          | 29.905                    |

FOR THE STATE OF PENNSYLVANIA,  
 collated from returns made to the Committee on Meteor-  
 ology of the Franklin Institute of the State of Pennsylv-  
 ania, for

| County.              | Town.             | Observer.               |
|----------------------|-------------------|-------------------------|
| 1 Philadelphia, .    |                   |                         |
| 2 Montgomery, .      |                   |                         |
| 3 Bucks, .           | Newtown, .        | L. H. Parsons, .        |
| 4 Lehigh, .          |                   |                         |
| 5 Northampton, .     |                   |                         |
| 6 Monroe, .          | Stroudsburg, .    | A. M. Stokes, .         |
| 7 Pike, .            |                   |                         |
| 8 Wayne, .           |                   |                         |
| 9 Schuylkill, .      | Silver Lake, .    | E. Rose, .              |
| 10 Luzerne, .        |                   |                         |
| 11 Schuylkill, .     | Pottsville, .     | John Porter, .          |
| 12 Berks, .          | Reading, .        | C. F. Egelman, .        |
| 13 Chester, .        |                   |                         |
| 14 Delaware, .       | Haverford, .      | Haverford School, .     |
| 15 Lancaster, .      | Lancaster, .      | Conservatory of Arts, . |
| 16 York, .           | York, .           | Calvin Mason, .         |
| 17 Lebanon, .        |                   |                         |
| 18 Dauphin, .        |                   |                         |
| 19 Northumberland, . | Northumberland, . | Andrew C. Huston, .     |
| 20 Columbia, .       | Danville, .       | C. H. Fricke, .         |
| 21 Bradford, .       |                   |                         |
| 22 Tioga, .          |                   |                         |
| 23 Lycoming, .       |                   |                         |
| 24 Union, .          |                   |                         |
| 25 Mifflin, .        | Lewistown, .      | J. Culbertson, M. D. .  |
| 26 Juniata, .        | Mifflintown, .    | J. A. Rinkead, .        |
| 27 Perry, .          |                   |                         |
| 28 Cumberland, .     | Carlisle, .       | Prof. W. H. Allen, .    |
| 29 Adams, .          | Gettysburg, .     | Prof. M. Jacobs, .      |
| 30 Franklin, .       | Chambersburg, .   |                         |
| 31 Huntingdon, .     |                   |                         |
| 32 Centre, .         | Bellefonte, .     | John Harris, .          |
| 33 Potter, .         |                   |                         |
| 34 McKean, .         | Smithport, .      | Richard Chadwick, .     |
| 35 Clearfield, .     |                   |                         |
| 36 Cambria, .        | Ebensburgh, .     | Richard Lewis, .        |
| 37 Bedford, .        |                   |                         |
| 38 Somerset, .       |                   |                         |
| 39 Indiana, .        | Indiana, .        | Richard White, .        |
| 40 Jefferson, .      | Rose Cottage, .   | C. C. Gaskell, .        |
| 41 Warren, .         |                   |                         |
| 42 Venango, .        |                   |                         |
| 43 Armstrong, .      |                   |                         |
| 44 Westmoreland, .   |                   |                         |
| 45 Fayette, .        |                   |                         |
| 46 Green, .          |                   |                         |
| 47 Washington, .     |                   |                         |
| 48 Allegheny, .      |                   |                         |
| 49 Beaver, .         |                   |                         |
| 50 Butler, .         | Butler, .         | Jacob Mechling, .       |
| 51 Mercer, .         |                   |                         |
| 52 Crawford, .       |                   |                         |
| 53 Erie, .           |                   |                         |

| Thermometer. |          |          |          |          |       |               |         |       |               | Barometer. |          |          |          |          |       | Weather.      |        |         |               |       |       | Winds.         |                  |                 |        |          |       |          |       |          |       |          |        |          |       | Hygrometer. |       |          |       |          |       |               |            |               |                             |           |               |                |
|--------------|----------|----------|----------|----------|-------|---------------|---------|-------|---------------|------------|----------|----------|----------|----------|-------|---------------|--------|---------|---------------|-------|-------|----------------|------------------|-----------------|--------|----------|-------|----------|-------|----------|-------|----------|--------|----------|-------|-------------|-------|----------|-------|----------|-------|---------------|------------|---------------|-----------------------------|-----------|---------------|----------------|
| 7. A. M.     | 2. P. M. | 9. P. M. | Maximum. | Minimum. | Mean. | Days omitted. | Lowest. | Mean. | Days omitted. | 7. A. M.   | 2. P. M. | 9. P. M. | Maximum. | Minimum. | Mean. | Days omitted. | Clear. | Cloudy. | Days omitted. | Rain. | Snow. | Rain and Snow. | Thunder Showers. | Rain in inches. | North. | N. N. E. | N. E. | E. N. E. | East. | E. S. E. | S. E. | S. S. E. | South. | S. S. W. | S. W. | W. S. W.    | West. | W. N. W. | N. W. | N. N. W. | Calm. | Days omitted. | Dew-point. | Days omitted. | Diff. therm. and dew point. | Wet Bulb. | Days omitted. | No. of Report. |
| 49.90        | 65.74    | 52.32    | 82.      | 32.      | 55.99 | 3             | 26.     | 42.07 | 3             | 30.18      | 30.14    | 30.17    | 30.59    | 29.47    | 30.16 | 1             | 13     | 15      | 2             | ..... | ..... | .....          | .....            | 2.150           | 7      | .        | 33    | .        | 23    | .        | 13    | .        | 73     | .        | 43    | .           | 2     | .        | 2     | .        | .     | .....         | .....      | .....         | .....                       | 892       |               |                |
| 43.80        | 61.72    | 48.45    | 75.      | 25.      | 51.32 | 24            | .....   | ..... | .             | 29.70      | 29.69    | 29.70    | 30.20    | 29.33    | 29.70 | 3             | 16     | 10      | 43            | ..... | ..... | .....          | .....            | 1.000           | 2      | .        | 3     | .        | 3     | .        | 13    | .        | 43     | .        | 63    | .           | 69    | .        | 3     | .        | 23    | .....         | .....      | 58.56         | 22                          | 850       |               |                |
| 49.90        | 63.71    | 56.19    | 80.      | 40.      | 56.60 | .             | 38.     | 44.97 | .             | 28.15      | 28.16    | 28.17    | 28.50    | 27.80    | 28.16 | .             | 16     | 14      | .             | 4     | ..... | .....          | .....            | 0.700           | .      | .        | .     | .        | .     | 1        | .     | 4        | .      | 10       | 2     | 6           | .     | 7        | .     | .        | ..... | .....         | .....      | .....         | 886                         |           |               |                |
| 48.34        | 63.32    | 51.73    | 76.      | 27.      | 54.46 | 84            | 24.     | 42.43 | 8             | 29.46      | 29.43    | 29.44    | 29.80    | 29.10    | 29.44 | 84            | 12     | 10      | 84            | ..... | ..... | .....          | .....            | 0.860           | 2      | .        | 13    | .        | .     | .        | 14    | .        | .      | 1        | .     | 2           | .     | 3        | .     | 10       | 94    | .....         | .....      | .....         | .....                       | 839       |               |                |
| 49.81        | 62.74    | 52.62    | 74.      | 29.      | 55.06 | .             | .....   | ..... | .             | 29.99      | 29.88    | 29.90    | 31.      | 29.05    | 29.92 | .             | 15     | 16      | 84            | 3     | ..... | .....          | .....            | 1.254           | 2      | .        | 13    | .        | .     | .        | 14    | .        | 34     | .        | 4     | 4           | 5     | .        | 14    | .        | 1     | .             | .....      | .....         | .....                       | .....     | 834           |                |
| 47.47        | 60.35    | 51.86    | 73.      | 39.      | 53.23 | 143           | 31.     | 47.50 | 15            | 29.73      | 29.76    | 29.73    | 30.24    | 27.87    | 29.74 | 123           | 1      | 9       | 21            | ..... | ..... | .....          | .....            | .....           | 13     | 13       | 23    | .        | 3     | .        | 3     | .        | 23     | 13       | 11    | .           | 1     | 13       | .     | 3        | 143   | .....         | .....      | .....         | .....                       | 884       |               |                |
| 49.47        | 67.07    | 54.97    | 80.      | 32.      | 57.17 | .             | 30.     | 47.48 | .             | 29.72      | 29.66    | 29.67    | 30.49    | 29.25    | 29.68 | .             | 21     | 10      | .             | 3     | ..... | .....          | .....            | 11.305          | 33     | 23       | 13    | .        | 3     | .        | 13    | .        | 23     | 1        | 1     | 13          | .     | 23       | 1     | .        | 51.81 | .....         | 58.68      | .....         | 865                         |           |               |                |
| 55.79        | 64.76    | 54.53    | 78.      | 39.      | 58.36 | .             | 32.     | 48.53 | .             | 29.75      | 29.73    | 29.75    | 30.20    | 29.40    | 29.74 | .             | .      | .       | .....         | ..... | ..... | .....          | 0.850            | .               | .      | .        | .     | 63       | .     | 3        | .     | 1        | .      | 23       | .     | 33          | .     | 16       | .     | .        | 44.35 | .....         | .....      | .....         | .....                       | 856       |               |                |
| 48.77        | 61.58    | 53.40    | 72.      | 35.      | 54.58 | .             | 23.     | 41.71 | .             | 29.62      | 29.62    | 29.60    | 30.03    | 29.20    | 29.61 | .             | 13     | 17      | .             | 3     | ..... | .....          | .....            | 1.492           | 7      | .        | 1     | .        | 1     | .        | 4     | .        | 5      | .        | 23    | .           | 23    | .        | 3     | .        | 3     | .             | .....      | .....         | 58.87                       | .         | 851           |                |
| .....        | .....    | .....    | .....    | .....    | ..... | .             | .....   | ..... | .             | 29.64      | 29.67    | 29.65    | 30.12    | 29.23    | 29.65 | 51            | 14     | 11      | 51            | ..... | ..... | .....          | .....            | 1.336           | 2      | .        | .     | .        | .     | .        | 13    | .        | .      | 23       | .     | 3           | .     | 3        | .     | 13       | 7     | .....         | .....      | .....         | .....                       | 1034      |               |                |
| 53.76        | 62.29    | 58.53    | 75.      | 42.      | 58.20 | 43            | .....   | ..... | .             | 29.46      | 29.40    | 29.43    | 29.81    | 29.10    | 29.43 | 34            | .      | .       | .....         | ..... | ..... | .....          | .....            | .....           | .      | .        | 33    | .        | .     | .        | 43    | .        | 1      | .        | 93    | .           | .     | 34       | .     | .        | 63    | .....         | .....      | .....         | .....                       | 837       |               |                |
| 49.98        | 66.79    | 53.93    | 78.      | 27.      | 56.90 | 23            | .....   | ..... | .             | 29.69      | 29.57    | 29.57    | 30.60    | 29.12    | 29.61 | 24            | 10     | 14      | 64            | ..... | ..... | .....          | .....            | 4.500           | .      | .        | 13    | .        | .     | .        | 5     | .        | .      | .        | 5     | .           | 3     | .        | 34    | .        | 13    | 13            | .....      | .....         | .....                       | .....     | 855           |                |
| 47.03        | 63.53    | 53.16    | 77.      | 28.      | 54.85 | .             | 27.     | 43.68 | .             | 29.61      | 29.53    | 29.58    | 30.      | 29.19    | 28.59 | .             | 17     | 14      | .             | ..... | ..... | .....          | .....            | 0.834           | 1      | .        | 1     | .        | 1     | .        | 3     | .        | 14     | 1        | 1     | 5           | .     | 4        | .     | 12       | .     | .....         | .....      | .....         | .....                       | 852       |               |                |
| 46.31        | 63.47    | 52.08    | 76.75    | 33.30    | 53.95 | .             | 38.     | 44.65 | .             | 29.58      | 29.57    | 29.55    | 29.96    | 29.19    | 29.57 | .             | 17     | 14      | .             | 3     | ..... | .....          | .....            | 0.825           | 1      | 13       | 5     | .        | 3     | .        | 11    | 5        | 14     | 3        | 3     | 13          | 4     | 2        | 3     | .        | .     | 49.84         | .....      | .....         | 56.40                       | .         | 888           |                |
| 43.93        | 60.55    | 51.04    | 76.      | 20.      | 51.84 | 3             | 18.     | 38.55 | 9             | 29.43      | 29.41    | 29.40    | 29.80    | 29.03    | 29.42 | 23            | 14     | 15      | 23            | ..... | ..... | .....          | .....            | 1.054           | 1      | .        | 43    | .        | .     | .        | 23    | .        | 43     | .        | 9     | 3           | 13    | .        | 3     | .        | 3     | 5             | .....      | .....         | .....                       | .....     | 890           |                |
| 42.81        | 63.84    | 47.81    | 80.      | 22.      | 51.49 | .             | 17.     | 39.61 | .             | 28.29      | 28.30    | 28.28    | 28.60    | 27.92    | 28.29 | .             | 15     | 15      | .             | ..... | ..... | .....          | .....            | 0.415           | 1      | .        | .     | .        | 5     | .        | 43    | .        | 23     | .        | 83    | .           | .     | 73       | 3     | 60.50    | 4     | .....         | 61.48      | .....         | 874                         |           |               |                |
| 49.37        | 59.84    | 53.63    | 73.      | 33.      | 54.29 | 7             | .....   | ..... | .             | 28.10      | 28.07    | 28.08    | 28.40    | 27.72    | 28.08 | 71            | .      | .       | .             | ..... | ..... | .....          | .....            | .....           | 2      | 3        | .     | .        | 13    | .        | 53    | .        | 4      | .        | 3     | 3           | 2     | 3        | .     | 3        | 73    | .....         | .....      | .....         | .....                       | 353       |               |                |
| 57.16        | 64.68    | 60.16    | 80.      | 40.      | 60.67 | .             | 28.     | 44.55 | .             | 28.75      | 28.74    | 28.74    | 29.10    | 28.40    | 28.74 | .             | 21     | 9       | .             | ..... | ..... | .....          | .....            | 0.896           | 2      | .        | 2     | .        | .     | .        | 63    | .        | .      | 5        | .     | 13          | .     | 13       | .     | 21       | .     | 123           | .          | .....         | .....                       | .....     | .....         | 867            |
| 41.13        | 62.69    | 49.94    | 80.      | 24.      | 51.25 | 3             | 23.     | 40.32 | .             | 29.13      | 29.07    | 29.07    | 29.80    | 28.55    | 29.09 | .             | 3      | 17      | 12            | 3     | ..... | .....          | .....            | 0.900           | 2      | .        | .     | .        | .     | .        | 23    | .        | .      | 13       | .     | 1           | 2     | .        | 21    | .        | 21    | 13            | 54.15      | 4             | .....                       | 60.52     | 4             | 866            |
| 46.99        | 66.23    | 56.26    | 80.      | 31.      | 59.83 | .             | .....   | ..... | .             | .....      | .....    | .....    | .....    | .....    | ..... | .             | 25     | 52      | .             | 1     | ..... | .....          | .....            | 1               | .....  | .        | 3     | .        | 13    | .        | 2     | .        | .      | 84       | .     | 4           | .     | .        | .     | .....    | ..... | .....         | .....      | 864           |                             |           |               |                |





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OF THE  
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AND  
**MECHANICS' REGISTER.**

MAY, 1840.

**Practical and Theoretical Mechanics and Chemistry.**

*On the Identity of Edwardsite and Monazite, by GUSTAV ROSE. Extracted from the 1st No. of Poggendorf's "Annalen der Physik und der Chemie" for 1840. By M. H. BOYE' AND J. C. BOOTH.*

The Royal collection at Berlin received a fragment of Gneiss from Norwich, in Connecticut, containing a part of a crystal of Edwardsite, which, although fractured on either termination, had a sufficient number of planes remaining to determine its angles. *Sheppard*\* correctly referred this mineral to the oblique-rhombic system, and added that the prism was terminated by a four sided pyramid. He observed that the cleavage was sometimes perfect but generally uneven parallel to the oblique terminal plane, but very perfect parallel to the longer diagonal. He further remarks that it bore the closest resemblance to zircon, which the Monazite was supposed to be by *Menge*, who first found it in the Ilmen branch of the Uralian chain. The few measurements of Edwardsite nearly correspond with those of Monazite, excepting the inclination of an oblique terminal plane to the plane replacing the obtuse lateral edge, which, with Monazite, gave an angle of  $100^{\circ} 3'$ , with Edwardsite  $103^{\circ} 58'$ , but the calculation of the former was grounded on imperfect measurements. In regard to form, therefore, the two minerals correspond.

They also resemble each other in relation to other properties. Color, hyacinth-red to reddish brown, the lustre of Edwardsite somewhat stronger; hardness = 5 (apatite). Specific gravity of Edwardsite is rated too low by *Sheppard* = 4.2 to 4.6,—that of Monazite, according to *Breithaupt* = 4.992 to 5.079. In behaviour before the blow pipe alone, or with fluxes

\* American Journal Arts and Science, xxxii, 162.

both alike, both infusible. Sheppard observes that the former fuses with great difficulty on the edges, but no such fusion was observable on the specimen in the Royal cabinet. There are some differences in their behaviour with acids, the former, according to Sheppard, being slightly affected by Aqua Regia, the Monazite, according to Kersten being decomposed by chlorohydric acid with the evolution of chlorine.

The apparent differences of their chemical composition may be reconciled. The Monazite was analyzed by Kersten, the Edwardsite by Sheppard.

| <i>Monazite.</i>        |         | <i>Edwardsite.</i>   |         |
|-------------------------|---------|----------------------|---------|
| Peroxide of Cerium,     | 26.00   | Peroxide of Cerium,  | 56.53   |
| Oxide of Lanthanium,    | 23.40   | Zirconia,            | 7.77    |
| Thorina,                | 17.95   | Alumina,             | 4.44    |
| Peroxide of Tin,        | 2.10    | Silica,              | 3.33    |
| Protoxide of Manganese, | 1.86    | Protoxide of iron, } | traces. |
| Lime,                   | 1.68    | Glucina, }           |         |
| Zitanic acid, }         | traces. | Magnesia, }          |         |
| Potassa, }              |         | Phosphoric acid,     | 26.66   |
| Phosphoric acid,        | 28.50   |                      | <hr/>   |
|                         | <hr/>   |                      | 98 73   |
|                         | 98.49*  |                      |         |

The chief differences then are that Monazite contains both oxide of cerium and lanthanium, the Edwardsite only peroxide of cerium (Sheppard gives protoxide,) that the former contains thorina, the latter zirconia. Lanthanium is probably contained in Edwardsite, as it generally accompanies cerium, having been first discovered during the past year by Mosander, (was unknown to Sheppard.) In regard to thorina and zirconia, it can hardly be assumed that the given quantities are correct, since we have no accurate method of separating them from oxide of cerium; it is, nevertheless, worthy of notice that 7.77 zirconia are a nearly full equivalent for 17.95 thorina, for the former contains 2.04, the thorina 2.12 oxygen. It might, therefore, be supposed that the thorina is replaced by zirconia in Edwardsite, which, however, cannot be assumed from the present view of their atomic composition, since, according to Berzelius, thorina is expressed by  $\text{Th} + \text{O}$ , zirconia by  $2 \text{Zr} + 3\text{O}$ . The tin in Monazite is evidently accidental from its minuteness, but remarkably enough, as Rose remarks, he found it also in Edwardsite, by means of the blow-pipe. If the presence of zirconia in Edwardsite be confirmed, and its isomorphy with thorina, then these two minerals can only be separated as species; if not, then both will probably agree in their chemical composition; in which case, it will be more proper to retain the name Monazite, which it first received.

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### Civil Engineering.

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*On the most Economical Angle of Splay for the Wing Walls of Culverts and Bridges.* By ELLWOOD MORRIS, Civil Engineer.

The immense number of bridges and culverts required upon our Public

\* There is evidently some error in the figures of this analysis, for the sum of those given is 101.49.

Works, renders it a matter of no small importance, that the most economical figure should be given to these structures.

It is true that occasionally the physical character of the site absolutely fixes the direction of the walls, but such cases are so rare as to form merely exceptions, and ought not to prevent the adoption of a general rule.

In constructing a Culvert, economy demands not only that the water way should be duly proportioned to the stream, and that the length of the Culvert be just sufficient to receive the embankment of the work; but also that its parapets should be of a certain size, and the wing walls splayed at a given angle.

For it can be demonstrated, 1st. That the most economical Culvert is that *which shows the least face*, or, other things being equal, has the lowest parapet. And 2nd. That there is *a certain angle of splay*, which requires less masonry in the wings than any other. The first branch of this subject it is not now proposed to enter upon, though we may remark, in passing, that to form the most economical, (and in point of fact also the most stable,) parapet, the coping of the Culvert should rest immediately upon the Keystone of the arch. And if there be any two culverts of the same water-way and splay of wing, one of which is *short* and has high parapets, whilst the other is *long* with low ones; the latter will contain far less masonry than the former.

To resume our subject. The main purpose of wing walls is to retain the embankment from obstructing the opening of culverts or bridges, though in culverts, they ought also to be so disposed as to aid the parapet in sustaining the end pressure of the embankment: fortunately, the most economical angle of splay (as we shall see hereafter) places the wings of culverts in a position highly suitable to subserve this object.

In these investigations we shall suppose the axis of the culvert or bridge to cross the line of direction of the embankment at right angles, and the *angle of Splay* to be the external angle, formed with the axis by the line of the wing produced; we shall also consider the height of the wing corner to be always such, that the curve of the foot of the embankment running around it at the proper slope shall, at the level of the culvert floor, be tangent to the prolongation of the abutment face; that the whole structure rests upon a horizontal plane, passed through the floor of the water way; that the faces of the wings are right lines; and finally, we shall (for the present) treat the wing walls as though they were planes without thickness.



Thus in the plan, figure 1, let

A B = The axis of a Bridge (under superstructure.)

C C = Centre line of the Embankment.

A F D or A F E = Angles of Splay.

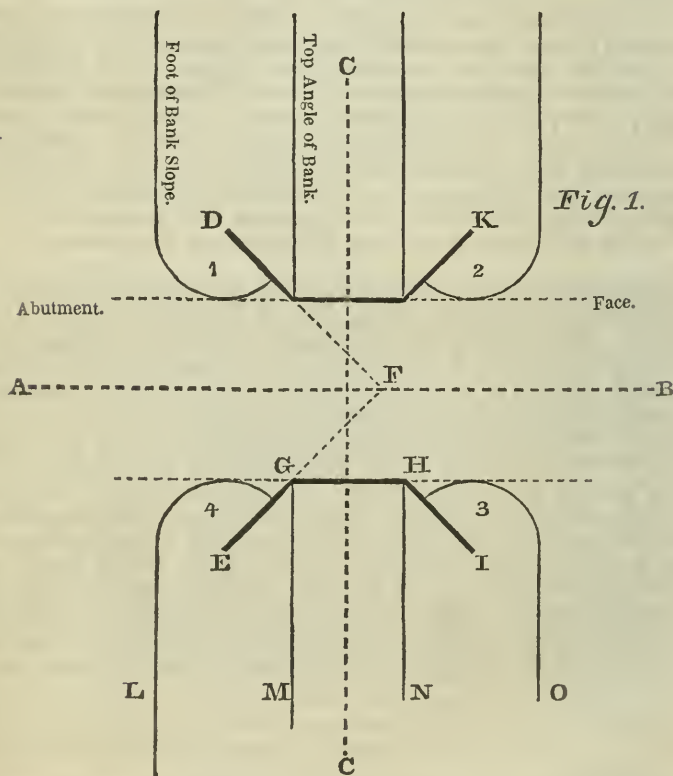
E G H I and D K = The Bridge Abutments and Wings.

E G and H I = Wing Walls.

M N = The top width of the Embankment.

L M and N O = The plans of the two Slopes.

1, 2, 3, 4, = The Embankment cones formed by training the material around the wing corners with the Embankment Slope.



From the nature of the subject, it is evident that when the wing is parallel to the line of direction of the embankment, or the *Angle of Splay* is  $90^\circ$ , the figure of the wing wall will be a parallelogram; that when it is perpendicular to the line of direction, or parallel to the axis, the *Splay Angle* being  $= 0^\circ$ , the face of the wing will present a triangle: and at any angle between these two positions, the surface of any wing wall will exhibit a trapezoid.

And it is further evident that when the wing is parallel to the line of bank, or when its face is a parallelogram, the surface is a *maximum*: now as the triangular wing is not that of the least surface, the question resolves itself into finding by the principles of maxima and minima, that wing amongst the trapezoidal forms, whose face shall be a *minimum*.

In figure 2, let

A B = A Wing Wall parallel to the bank, *Splay Angle*  $90^\circ$ .

A C = A Wing Wall parallel to the axis, *Splay Angle*  $0^\circ$ . Both being represented in plan.

Join B C, then will A be the origin of every possible wing wall, and the line B C the terminating or corner line of all, which satisfies the prescribed condition of just retaining the embankment from obstructing the water way. The height of the corner B of the parallelogram wing A B = height of Bank. And the altitude of the corner C of the triangle wing A C = 0.

Hence the mean height of the wing wall on the line A B = the height of the bank: on the line A C = one-half of that height: and in the trapezoidal forms the average heights of the walls, will be more than one half but less than the whole height of the bank.

Now prolong A B to F and make B F equal to the embankment height, and from C parallel to A B draw C E, and make it equal to one-half of the altitude of the embankment: join E F: then any line as I N drawn between the lines B C and F E, parallel to A F or C E, will represent the mean height of the wing wall whose base is the line I A, drawn from the intersection I, upon the corner line, to the origin A. And as the mean altitude of a trapezoid, multiplied by its length, is equal to the area, we have only to find the *Angle of Splay* G A I, such that the rectangle of any two lines, related like A I and I N, shall be a minimum.

Let us now consider the embankment slopes; A B or A C represents the base of a slope of which the altitude is B F (that of the bank.)

Therefore (figure 2) let

$r$  = The slope ratio or the base to a rise of unity.

$x$  = The abscissa A G of any wing wall.

$y$  = The corresponding ordinate G I.

$z$  = Any height line as I N.

Then

$$\text{When } x = 0 \quad z = A B \div r = y \times \frac{1}{r} = \frac{y}{r} = B F$$

$$\text{When } y = 0 \quad z = \frac{A C}{2} \div r = \frac{1}{2}x \times \frac{1}{r} = \frac{\frac{1}{2}x}{r} = C E.$$

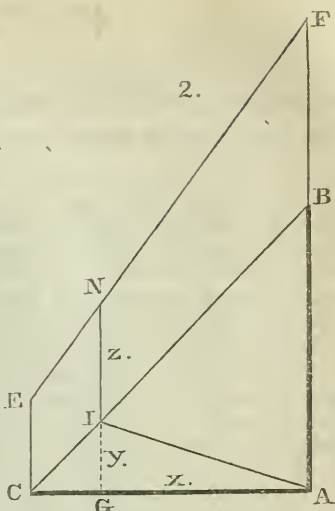
Therefore generally,

$$z \text{ or } I N = \frac{\frac{1}{2}x + y}{r}$$

The base of any wing or the length of any line such as A I,

$$\text{Being manifestly} = \sqrt{x^2 + y^2}.$$

Consequently the general formula representing the area of any wing wall whose base lies in the angle B A C, is,



$$\left( \frac{\frac{1}{2}x + y}{r} \sqrt{x^2 + y^2} \right) = \text{Area.}$$

Treating this equation\* by the principles of maxima and minima, we find the *minimum area* to have place when

*The Tangent of the Splay Angle C A I* =  $\frac{1}{3}$  or the *Angle of Splay* =  $18^\circ 26'$ .

This angle (see C A I, fig. 2, which is drawn =  $18^\circ 26'$ ) gives for the direction of culvert wing walls such a position as enables them to perform the important office of sustaining the parapet (against the outward thrust of the bank, which takes place in the direction A C,) besides containing a minimum surface:—In ordinary bridge abutments it is not often a matter of any importance in what direction the wing splays; and hence no reason of moment has occurred to the writer why a splay angle near  $18^\circ 26'$  might not be generally adopted.

Such is the theoretical deduction, supposing the wing walls to be planes, but in actual practice, owing to a portion of the wing being intercepted by the thickness of the abutment or parapet, the minimum wing in *cubic content*, has seldom a splay angle of *exactly*  $18^\circ 26'$ , but the above investigation points out the limit which should be approximated.

To fulfil precisely the conditions required by economy, it is important that the splay of the face of the wings should originate in the abutment corner, and not, as is usual in Culverts, at some two or three feet from the face of the abutment. This plan of returning the abutment the length of the ring-stone or more, has arisen from two reasons, first, with the view of securing a firmer bond of the wing and parapet back of the spandrel; and secondly, to improve the facade by displaying the whole front of the arch.

The former condition (that of solidity) we believe can, with little difficulty, be secured with wings originating at the abutment corner; and the latter being merely a matter of taste is not of paramount importance. With regard to bridge abutments no objection can be urged against splaying the wings from the abutment corners, that being the usual method.

We will conclude by subjoining a table showing the cubic content (at various splays) of *one wing*, both of a Bridge abutment and Culvert; supposing the mean thickness to be five feet: the abutment of bridge and parapet of Culvert same thickness, the altitude of each above the horizontal plane twenty feet, and all plumb both front and rear.

Also supposing the bridge wing to end in a vertical plane perpendicular to the abutment at five feet from the corner, or in fact (for the sake of comparison) including in each five feet lineal of the abutment; whilst the culvert wing is supposed to terminate in a vertical plane passed perpendicular to the parapet through its face angle of junction with the wing.

All answering the condition prescribed for wings, the slope of the embankment being assumed at  $1\frac{1}{2}$  to 1.

\* I have omitted the work of reducing this expression, as the result can be easily verified by any one acquainted with the first principles of the calculus.



Table of Wing Contents.

| No. | Splay.          |                                     | Length of wings on the front line. | Bridge abutment wings. | Culvert wings.  | Face areas of one wing of each. | Dimensions common to both. |                           |
|-----|-----------------|-------------------------------------|------------------------------------|------------------------|-----------------|---------------------------------|----------------------------|---------------------------|
|     | Angle of Splay. | Tangt. of angle to a rad. of unity. |                                    | Solid contents.        | Solid contents. |                                 | Depression of wing cor.    | Dist. out of wing corner. |
|     |                 | Degrees and Minutes.                | Feet.                              | Perches.               | Perches.        | Feet superficial.               | Feet Lineal.               | Feet Lineal.              |
| 1   | 0° 0'           | 0                                   | 30.                                | 80.                    | 80.             | 300.                            | —20.                       | 30.                       |
| 2   | 11° 19'         | $\frac{1}{5}$                       | 23.72                              | 77.92                  | 76.32           | 297.5                           | —16 $\frac{2}{3}$          | 25.                       |
| 3   | 14° 02'         | $\frac{1}{4}$                       | 24.74                              | 77.40                  | 75.48           | 296.8                           | —16.                       | 24.                       |
| 4   | 18° 26'         | $\frac{1}{3}$                       | 25.49                              | 76.68                  | 74.32           | 296.5                           | —15.                       | 22.5                      |
| 5   | 26° 34'         | $\frac{1}{2}$                       | 22.36                              | 75.72                  | 72.80           | 298.2                           | —13 $\frac{1}{3}$          | 20.                       |
| 6   | 45°             | 1                                   | 21.21                              | 76.40                  | 73.12           | 318.1                           | —10.                       | 15.                       |
| 7   | 63° 26'         | 2                                   | 22.36                              | 85.60                  | 80.28           | 374.                            | —6 $\frac{2}{3}$           | 10.                       |
| 8   | 71° 34'         | 3                                   | 23.72                              | 89.52                  | 87.16           | 415.1                           | —5.                        | 7.5                       |
| 9   | 75° 58'         | 4                                   | 24.74                              | 94.24                  | 92.32           | 445.3                           | —4.                        | 6.                        |
| 10  | 78° 41'         | 5                                   | 25.49                              | 97.76                  | 96.12           | 580.                            | —3 $\frac{1}{3}$           | 5.                        |
| 11  | 90°             | Infinite                            | 30.                                | 120.                   | 120.            | 600.                            | 0.                         | 0.                        |

In consequence of the thickness of abutment, or parapet, intercepting a portion of the wing wall, and modifying the theoretical result, it will be perceived by the table that although No. 4, whose splay angle is 18° 26' has a *minimum surface*,

Yet No. 5 with an angle of splay of 26° 34'\* has a *minimum capacity*.

We may also observe that taking the greatest and least wings and multiplying them by four (the usual number,) we have for their difference as follows:

#### Wings of Bridge Abutments.

|                          |   |   |        |          |
|--------------------------|---|---|--------|----------|
| 4 wings, such as No. 11. | - | - | 480.   | Perches. |
| Do. do. No. 5.           | - | - | 302.88 | "        |

Difference in one bridge of the assumed dimensions 177.12 "

#### Wings of Culverts.

|                          |   |   |       |          |
|--------------------------|---|---|-------|----------|
| 4 wings, such as No. 11. | - | - | 480.  | perches. |
| Do. do. No. 5.           | - | - | 291.2 | "        |

Difference in one culvert of the assumed size, 188.8 "

From the above we may deduce this practical inference, that when economy is desirable,

*The splay angle of the wing walls of bridge abutments and culverts, ought not to be less than 18° 26', nor more than 45°.*

Though between these limits, the Angle of splay may vary without ma-

\* This Splay Angle of 26° 34' is that prescribed in some of the specifications for culverts upon the Chesapeake and Ohio Canal, drawn up by the present Chief Engineer, and recently in force on that work.

terial loss, and *the thinner* the wing wall, *the closer* will it approximate to No. 4 of the table, the theoretical minimum:

Oldtown, Md. April 26th, 1840.

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## Franklin Institute.

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### *Sixty-fifth Quarterly Report of the Board of Managers of the Franklin Institute, of the State of Pennsylvania, for the promotion of the Mechanic Arts.*

The Board of Managers respectfully submit to the members of the Franklin Institute their quarterly report.

The lectures of the Institute were closed on the 25th of March, after a session of much interest. In addition to the regular courses upon Chemistry, Natural Philosophy and Technology, by Professors J. K. Mitchell, J. C. Cresson and J. C. Booth, several volunteer lectures were given by J. F. Frazer, Esq., on Geology, and by J. S. Silver, Esq., on the Anthracite region of Pennsylvania.

To these gentlemen the thanks of the Board are tendered, for their efficient services in promoting the usefulness of the Institute, and the hope is indulged that we may be favoured next season with a more extended series of voluntary contributions.

Much to the regret of the Board, and disappointment of the numerous applicants, the drawing school was closed during the early part of the winter, in consequence of the protracted illness of Mr. William Mason; arrangements were, however, made for opening the school under the charge of Mr. Mason's Son, Mr. S. R. Mason, in time for the completion of one quarter, and it has been conducted by him in a manner entirely satisfactory. The number of scholars in attendance was 41.

The Library continues to increase by donations, by purchase and exchanges with the Journal. The additions from the latter source are numerous, and it is believed, may become still more important as a knowledge of the value of our Journal is extended at home and abroad.

For the promotion of this desirable object, the Board would urge upon the members of the Institute, the propriety of contributing more freely to its pages. Among the thousands who are partaking of the benefits of the Institute, there are many who possess the kind of knowledge which is peculiarly appropriate to our volume. Practical observations upon matters of daily or occasional experience, new processes, and convenient arrangements in the arts, the success or failure of experiments, and a great variety of similar material which is abundantly possessed by our members, would add much to the interest of the journal, and be highly creditable to the contributors.

The cabinets of models and minerals have both received valuable additions during the quarter, and the Committees who have them in charge have completed their arrangement.

A desire having been expressed by some of those who are most deeply interested that an exhibition of domestic manufactures should be held this year, the Committee on Premiums and Exhibitions, are taking the preliminary steps, and will shortly announce to the public, the progress of their arrangements.

The monthly conversation meetings, are sustained with much spirit, and appear to be increasing in favour with our members.

It should be borne in mind that the continued interest of these meetings must depend upon the zeal and readiness of our members, in providing the proper materials for their support.

The Committee on Science and the Arts continue their useful labours, and have reported upon several inventions submitted for their judgment.

For the information of members and others interested in the affairs of the Institute, the Board has directed the printing in pamphlet form, the Constitution, By-laws, and arrangement of the Committees of the Institute. The preparation for the press is completed, and when printed it will be placed at the disposal of members.

In addition to the usual standing Committees, the Board has recently constituted another, styled the Committee on the Cabinet of Arts and Manufactures, whose duties will consist in the collection and preservation of specimens designed to exhibit the past and progressive condition of the arts, which must become in time a source not only of much gratification to the inquisitive, but of useful instruction and historical interest.

During the past quarter, twenty-seven new members have been elected, and eight members have resigned their memberships.

The following gentlemen have become life members:—

Thomas Mellor, James Christy, Thomas Firth, and William D. Parrish. The Treasurer's report is herewith presented.

JOHN C. CRESSON, Chairman.

WILLIAM HAMILTON, Actuary.

April 15th, 1840.

#### COMMITTEE ON SCIENCE AND THE ARTS.

##### *Report on Dr. Rhoads' Maps for the Blind.*

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a new plan for making Maps for the Blind, by Dr. J. Rhoads, Principal of the Pennsylvania Institution for the Instruction of the Blind, REPORT:

That "various plans have been proposed and executed, from time to time, for making maps which the Blind can use by the touch. Of these, the greater part,—such as those which are embossed and printed in relief,—have to be made exclusively for the Blind, and are therefore either very expensive or very imperfect. A method, therefore, by which an ordinary map may be made sensible to the touch, must present a great advantage. Heretofore the only plan of this kind that can be considered successful, is to mark the lines, &c., by pricking the map through, from the back, with a point; a succession of burs is thus formed on the face, which may be distinguished by the fingers. This method is used only, (as is believed,) in the German Institutions and that in Philadelphia. It has the disadvantage of presenting but one kind of mark, and that this mark is subject to become blunted by use. Dr. Rhoads also uses a common map, and he makes it a tangible one, by the following process. Oceans, lakes, and bays are marked by covering the spaces with fish-glue and then spreading sand on it. When the glue hardens, the sand remains permanently attached. Rivers are marked by threads of cotton, formed into bundles of greater or less thickness, made to follow all the sinuosities of the engraving on the original



map, and fastened by fish-glue. When rivers are boundaries, however, they are distinguished by gluing a line of sand over the marks on the map. Artificial boundaries are marked by narrow strips of paste-board. Towns are marked by round pieces of paste-board,—or, by square pieces if they are capitals. Numbers, as printed in relief for the Blind, are fastened upon prominent points and places on the map, and give reference to a table at the side, in which the corresponding names are given, also printed in relief.

A map of this kind, the basis of which is Tanner's large map of the United States, is hung up in one of the rooms of the Institute, and enables the members to judge how well it accomplishes the object in view. To its other merits, it adds that of cheapness, as this map was executed by a young woman in ten days.

Dr. Rhoads' plan is equally applicable to globes, and he has made one of the kind for the use of his pupils.

Some of the members of the Committee have had frequent opportunities of seeing Dr. Rhoads' maps and globe, used by the blind, and can give evidence that they answer perfectly the purpose of their construction.

The Committee, in view of the various merits of this plan, have great satisfaction in making a decided report in its favour, and respectfully recommend it to the Board of Managers, as worthy of the Scott Legacy Premium.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

Philadelphia, May 14th, 1840.

*Report on a Coining Press at the United States Mint, Philadelphia.*

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, the Coining Press recently put in operation at the United States Mint, in this City, REPORT:—

That, an early opportunity was taken to visit the Mint and examine the machine in question; of which the following description and historical notice has been kindly furnished to the Committee, by F. Peale, Esq., Chief Coiner, under whose direction the new coining machinery has been constructed.

This press resembles in general form, but differs considerably in detail from, the first one put into operation in the Mint in 1836, of which a short notice was published in the Journal of the Franklin Institute, (Vol. XVIII. No. 307.) The changes which have been made in it are the result of some years' experience, and by the adoption of which its operation has been materially improved.

Four fluted Doric columns of heavy proportions, stand upon a low pedestal, and support a table of cast iron upon which is placed the arch for sustaining the pressure, and the plummer blocks and other supports for the working parts of the press. This table and arch were planed, and are finished with as high a degree of polish as the metal is capable of receiving. The shaft receives motion by means of a pulley and strap from the Steam Engine, and is furnished with a loose pulley for suspending its operation. A crank upon the shaft gives motion through a connecting piece to the lever, the forward end of which forms a part of the toggle joint, by the action of which the pressure is given to the planchets. Upon the shaft at the side of the table is the fly wheel, constructed with a *friction hub* with

tightening screws, an important provision to prevent the injury that would inevitably occur from the accidental presence of two pieces between the dies, at the same time. Upon the shaft is also placed an eccentric with a metallic strap, furnished with a regulating screw moving a lever by means of which the feeding carriage is brought forward; during its advance, it raises, by inclined planes, the *stake* or block containing the lower die, to the level of the collar in which the piece is struck, and which is sustained by a *platform* connected with the arch of the press, at the proper time to permit the piece which has received its impression to be pushed off by the *feeders* which are advancing with a fresh planchet, after depositing which, they return and take the lowest from a pile contained in a tube placed upon the platform. The opening and closing of the feeders upon the planchets, is accomplished by a friction slide working in guide grooves in the platform. The upper die is held by adjusting screws in a pivoted triangular guide, whose socket supports the ball of the lower part of the toggle joint; this triangular guide, lower joint and part of the lever, are supported by a jointed *bridle*, having the same motion as the toggle joint, and connected by pivots with the arch of the press. The eccentric and lifters, last mentioned, are late improvements, which have materially added to the efficiency of this press, producing a smooth/easy action, whilst the press is in operation at the rate of eighty-four revolutions per minute. The principal journals are oiled by syphon wicks in oil cups placed upon the caps of the boxes, in the classic form of small Etruscan vases.

The heavier parts of this press are of cast iron from the Foundry of Messrs. Merrick and Town, of this city, and are superior specimens of moulding and casting; the planing was also excellently executed in the establishment of these gentlemen. Many of the working parts, such as the lever and triangle, are of bronze, an alloy of copper and tin, in the proportions of nine of the former to one of the latter, being of a beautiful colour, working well, and retaining its lustre in an eminent degree, and for the above reasons deemed preferable to brass. The larger pieces were cast by the Messrs. Ames, at Cabotville, near Springfield, in Massachusetts, the smaller parts by Mr. Dyer of this city. The first named gentlemen, by their skill and care, have arrived at great perfection in this difficult art. Mr. Dyer also, by his perseverance, aided by free communication with the Messrs. Ames, has been very successful, and now furnishes castings of this alloy in every respect satisfactory.

All the small parts of the press are of steel, the heads of the screws and those parts exposed to friction, being hardened and tempered; the joints and fittings are executed with the 'greatest exactness and truth, and the whole has been finished to the highest possible degree.

We present the following note of the history of these presses.

In the "Bulletin de la Société d'encouragement, of June 1836, there appears a report by M. Francœur, on the coining press of M. Thonnellier of Paris, in which the merits of a press of similar principles, are warmly presented, and it is therein avowed that a press of the same character had been in successful operation at least eight years before in Munich, and that it is in the simplification and improvement of the German press, that M. Thonnellier has completely fulfilled the objects in view.

During a mission to Europe, for the Government, in 1834, for the purpose of investigating the various processes connected with Mint operations, Mr. Peale was present at a trial of the press of M. Thonnellier in Paris, and also saw the German presses in operation in Carlsruhe, in the Grand Duchy

of Baden. After his return, a press upon similar principles was constructed for the Mint of the United States, and has been ever since in operation. Neither the German press nor the French improvement was satisfactory to Mr. Peale, and the result of his views and experience has been the construction of the press under consideration, with all possible care and attention, in the workshop of the Mint, and which has completely satisfied every anticipation and desire.

The rate of operation is as follows, eighty-four revolutions per minute enables the press to strike five thousand pieces per hour, leaving a short interval for the removal of the boxes containing the coin, cleaning, oiling, &c. This rate has been maintained for ten hours, the usual duration of a day's work at the Mint, which gives 50,000 pieces, but it is by no means the maximum, for satisfactory experiments have shown that one hundred pieces might be struck per minute; but the above rate has been adopted as the most advantageous, and at the same time sufficiently expeditious. It is scarcely necessary to add, that the attendance of one person is all that is required for this press, and that attention, and not personal labour, is all that is necessary to supply planchets and maintain it in proper order.

The press had been in operation during some weeks, and in that time had coined many hundred thousand pieces without a single accident, or the slightest evidence of a want of perfect accuracy of performance. Beside this individual machine, to which the attention of the Committee was especially directed, and which merits the highest admiration for its judicious arrangement, excellence of workmanship, and great beauty of finish, the Committee examined several other presses and milling engines, which manifest good taste and mechanical skill, in a degree but little inferior to this last specimen. The steam engine also which drives the presses, and some other machinery, exhibits the beau ideal of motive power, and while it appears to possess all the essentials for efficient action, has sufficient symmetry and cleanliness for a piece of parlour furniture. An occasional visit to the Mint, and examination of its machinery, would, it is believed, be of much benefit to master mechanics, by improving their taste for the beautiful, and by shewing them how great room for improvement in workmanship and neat arrangement, exists in most manufacturing establishments. It may be added that the well known urbanity of the gentleman who has effected these excellent improvements, will insure an agreeable reception to all who may be inclined to avail themselves of this practical School of Arts.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

Philadelphia, May 14th, 1840.

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*Notice of the Conversation Meeting of the Franklin Institute, held at the Hall, April 23, 1840.*

The fifth Conversation Meeting of the season was held at the Hall of the Institute on the evening of Thursday, April 23rd. Among other objects of interest exhibited at this meeting, were a number of samples of castings from the foundry of Messrs. Savery & Co., which evince a great improvement in this important art; the flat and hollowware was almost as thin and as smooth as if made of sheet iron, and seemed perfectly sound and strong. A pair of cast fire irons from the same factory, had received a galvanizing coat of zinc and copper, by the process of Mr. T. Loring, to which



a polish had been given, equal in lustre, to burnished silver, said to be durable and cheap.

Mr. Thomas Loring, also exhibited several pieces of iron-tubing, covered with a protecting coating of the same alloy, upon which it is understood some experiments are now in progress, for the purpose of ascertaining its efficacy.

J. J. Mapes, Esq., of New York, editor of the *American Repertory*, shewed several specimens of Photographic portraits, executed by Mr. WALCOTT, of that city, which were much admired for strength of light.

Several beautiful portraits by the same process, executed by Mr. Robert Cornelius and Dr. Goddard, were exhibited by the latter gentleman. Mr. Joseph Saxton, produced a galvanic copy of a Photographic landscape, which, although manifestly imperfect, as the result of a first attempt, gives promise that these two novelties of science may be advantageously united. Professor Cresson gave a brief lecture on the continuance of vision, after the withdrawal of the visible object, which was illustrated by a modification of the Kaleidophone, on a large scale, and an instrument termed an ellipsarium, in which several luminous points are made to describe elliptical paths with sufficient speed to produce a permanent image of the whole path.

Much interest was excited by the exhibition of some specimens of the galvanic iris produced by the action of a galvanic current upon plates of polished steel, the specimens shewn were received by M. W. Baldwin, Esq. from Sir Michael Faraday. Mr. Baldwin gave an explanation of the process as witnessed by him at the Royal Institution, London.

The number of members and visitors present, was large, and the meeting one of considerable animation and interest.

#### SPECIFICATIONS OF ENGLISH PATENTS.

*Specification of a patent granted to WILLIAM GOSSAGE, of the county of Worcester, for his invention of certain improvements in manufacturing Iron.*—[Sealed 18th June, 1838.]

The method of converting pig, or crude, iron into malleable iron, by first melting the pig, or crude, iron in a furnace, called a "finery," and separating a considerable portion of the earthy impurities contained in such iron, and afterwards submitting the iron to the process called "puddling," and subsequently to the operation called "shingling," is well known.

It is also known to manufacturers of malleable iron, that during the operation called "shingling," as conducted in the above-mentioned method of converting pig, or crude, iron into malleable iron, a large quantity of black scoria, which is technically called "hammer slag," is separated from the metallic iron; and that this hammer slag consists of iron combined with oxygen, and is nearly free from earthy matter.

An improvement upon the above-mentioned method of converting pig or crude iron into malleable iron has been adopted, which improvement consists in using the hammer slag, obtained as before described, for the purpose of purifying pig or crude iron, and converting such iron into malleable iron by the operation called puddling, without the previous application of the finery process.

In working according to this improvement, hammer slag is put into the puddling furnace with pig or crude iron, in the first instance, and the oper-

ation of puddling then proceeds, according to a method well known; during which operation, a boiling up, or effervescence, takes place, and the earthy impurities become fluxed into cinder, which separates from the iron.

After the operation, called puddling, has been completed, the iron which has been separated is submitted to the process called shingling, in the same manner as is practised in working upon the old method, and a black scoria, which is also called hammer slag, is thereby separated from it; which hammer slag consists of iron combined with oxygen, but it also contains a considerable portion of earthy matters, which render this hammer slag unfit to be used for purifying pig or crude iron in the puddling furnace.

The manufacturer is therefore obliged to continue the finery process in part, in order to obtain hammer slag of suitable quality to be used for purifying pig or crude iron, in the puddling furnace, in the first instance.

I consider that the action of the hammer slag, used in the puddling furnace, as herein referred to, consists in furnishing oxygen, which disengages the carbon contained in the pig or crude iron, and in supplying oxide of iron, which, combining with earthy impurities contained in such pig or crude iron, forms the fusible compound called cinder.

One of the objects of my invention is to supply a cheap material, to be used as a substitute for hammer slag in puddling pig or crude iron. For this purpose I use the common argillaceous iron-stone, which is found generally in the coal districts of this country. This material contains oxide of iron, combined with carbonic acid, and by roasting or calcining it, in the ordinary method, I convert the carbonate of iron which it contains, into oxide of iron, and render the stone capable of being more easily reduced to powder. I then powder the calcined stone, and when this is powdered, it may be applied alone to the pig or crude iron in the puddling furnaces; but I prefer to mix the powdered stone with lime, in powder, either in the state of quick-lime or in the state of carbonate of lime.

The quantities of materials I usually employ for 450 pounds of pig or crude iron, of average quality, are 30 pounds of calcined iron-stone, and five pounds of slacked lime. I introduce the mixed powder into the puddling furnace, at the same time as the pig or crude iron, closing the damper of the furnace to prevent the powdery materials being carried off by the chimney draft. I then conduct the operation of puddling in the same manner as when hammer slag is employed.

As argillaceous iron-stone varies in the proportions of earthy matter and oxide of iron which it contains, so the quantity of this stone, required for purifying a given weight of pig or crude iron, will consequently vary. I find the proportions which I have stated, suitable when the iron which I use, contains from 40 to 50 per cent. of oxide of iron, and when this is applied to pig or crude iron of fair average quality. The proportion of lime required will vary according to the proportion of earthy matter contained in the pig or crude iron, and iron-stone respectively; but, as it is not customary for manufacturers of iron to investigate, with accuracy, the constitution of the pig or crude iron, or other materials which they employ, the most convenient mode will be to judge of the suitable proportions of iron-stone and lime by the progress of the operations. If the workman finds that the cinder produced does not become sufficiently fluid to separate freely from the malleable iron, he should increase the proportion of lime employed; and if the boiling up, or effervescence, which occurs during the puddling is not sufficient, he should increase the proportion

of iron-stone employed; but it will be understood that these last-mentioned directions are intended to apply only to subsequent operations, and that it will not be necessary, in any instance, to vary the proportions of any of the ingredients employed after the operation of puddling has been commenced.

My improvements, in the manufacture of iron, also consist in the construction of a more durable sole for the furnaces employed in the operation of puddling. In the furnaces usually employed for this purpose, the sole is a plate of cast iron, which is protected from the action of the fire by hammer slag and iron scale; but, instead of a sole of cast iron, which requires this protection, I use a sole of such grit stone as possesses the quality of resisting the action of fire. The stone which is usually employed for forming the hearths of iron smelting furnaces is suitable for the above purpose. I make this sole with either one entire block of stone, or with several blocks fitted together without cement.

I construct the sole in a form similar to that of the puddling furnaces now in use, to provide for running off the cinder, and I cause it to be sufficiently dished, or hollowed out, to retain the cinder without allowing it to come in contact with the walls of the furnace. I prefer that the sole should not be less than nine inches thick in any part; and as the furnaces will be similar to those now in use, in all respects, except as above described, I do not consider it necessary to give any further description of them.

The qualities required in the material used for constructing the furnace sole, according to my improvements, are a capability of enduring the action of fire, and such compactness and hardness as will best resist the chemical action of the fluxes to which the sole will be exposed in puddling iron, and which qualities are found in the grit stones used for the hearth stones in blast furnaces.

Having now described the nature of my said improvements, and the mode of carrying the same into effect, I claim as my invention, the use of argillaceous iron-stone in the conversion of pig or crude iron into malleable iron, by the process called puddling, whether this argillaceous iron stone be used with lime or other fluxing materials, or be used alone. And I claim the use of lime as a fluxing material, when used with any kind of iron-stone, or oxide of iron, in the conversion of pig or crude iron into malleable iron, by the process called puddling. And I claim, lastly, the use of such kind of stone, as I have herein described, for constructing the soles of furnaces for puddling iron.

Jour. Arts & Science.

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*Specification of a patent granted to MATTHEW UZIELLI, of the city of London, for improvements in the modes of Impregnating Wood or Timber with Chemical materials.*—[Sealed September 4, 1839.

To all to whom these presents shall come, &c. &c.—*Now know ye*, that in compliance with the said proviso, I, the said Matthew Uzielli, do hereby declare the nature of the said invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following statement thereof (that is to say):—

The improvements in impregnating wood or timber are performed by calling into play a natural power which will be found to exist in trees recently felled, and which causes the introduction into all parts of their substance of any liquid in which their lower extremities are immersed a few



inches. The most favourable time to proceed to this preparation, is when the circulation of the sap is most active, and when trees are most covered with leaves. Experience has proved that the circulation has sufficient energy to produce the most satisfactory results during the months of May, June, July, August, and September, in certain species of trees it continues in October and November; pine and fir belong to the latter. Preservative liquids, and others can be applied in whatever position the tree is placed, by steeping its foot in a vessel containing the liquor it is desired to impregnate the timber with. But as a great expense of manual labour can be avoided by preparing the trees when lying down, their preparation ought to be proceeded with, by adapting (as soon as possible after they are hewed down) to their lower extremity an apparatus in the shape of a bag, made of water-proof cloth answering as a reservoir, which is constantly kept full of the liquid to be absorbed. The greater the number of limbs and of leaves left upon the tree, and the sooner the operation takes place after it is cut down, the surer and more complete the penetration will be, yet the possibility of introducing the liquid to a considerable extent has been ascertained, even after several days had elapsed since the tree was felled and had been deprived of its limbs. It is important that this circumstance should be known, for in many instances it may serve to avoid operating on the spot, and permit the establishment of central depots for the preparation. The time required for the operation seldom exceeds ten days, its duration depends on the vigor of the tree, on its species, on its age, and on the season of the year. Of all the matters which have been introduced into timber by the mode pointed out above, those which deserve the preference for its preservation are the unrefined pyrolignites (acetates) of iron and copper. All their elements, among which is creosote, are already known as good preservatives, and their cost, particularly that of the first named, is very trifling. Though a decided preference is given to these salts, great reliance can be placed, in others; amongst them chloride of sodium (common salt) and arsenious acid (white arsenic) are to be particularly noticed; pieces of timber prepared with these substances have been submitted to powerful causes of alteration, and it has already been possible to ascertain that their protecting effect is very remarkable. To lessen the inflammability, and particularly the combustibility of timber, it is to be impregnated with chloride of sodium (common salt,) or with what is still better, a concentrated solution of chloride of calcium (muriate of lime,) shewing twelve degrees by Baume's areometer. The peculiar quality of rendering timber impermeable to moisture, is obtained by the introduction of resins dissolved, either in spirits of turpentine or in alcohol or pyroxylic spirits (wood-spirit, wood-naphtha,) the same dissolvents permit the introduction of camphor and all essential oils.

Finally. Valuable colours can be given to white wood by penetrating it with sulphate of indigo, or a solution of pernambuco wood. The warping of wood has always been prevented by the introduction of chloride of sodium (common salt) or of chloride of calcium (muriate of lime.) I would remark that I do not confine myself to any particular solution for impregnating timber or wood; the invention secured by the present letters patent, not depending on the materials it is desired to impregnate the timber or wood with, but to the mode of applying it to wood or timber in such manner as to take advantage of the natural circulation, thus rendering the employment of very large tanks unnecessary, as only the lower ends of trees or timber are required to be immersed in the liquor.

*Specification of a patent granted to WILLIAM HAWES, for improvements in the manufacturing of soap; parts of which improvements are applicable to preparing tallow for the manufacture of candles.*—Sealed 12th June, 1839.

This invention is for a method of obtaining saponification, by mechanical means, instead of boiling the tallow or other fatty materials with the alkaline leys, as in the ordinary process of soap making.

An upright shaft, having radial arms affixed thereto, is placed or mounted in the boiler, or other vessel containing the tallow or other fatty materials, and is caused to revolve by any suitable mechanical contrivance. Upon the upright shaft being put in motion, the alkaline ley is poured in slowly, and a perfect incorporation of the ingredients takes place, by means of the radial arms on the upright shaft. Other mechanical contrivances may be adopted to cause the required admixture of the materials, but the patentee prefers the one mentioned.

The tallow in the boiler is to be kept at as low a temperature as is compatible with its remaining in a state of fluidity. No alteration in the proportions of the ingredients is required; and it is easy to ascertain when saponification takes place, as the ingredients begin to thicken directly after it commences.

The same mechanical contrivance is used for producing the saponification of tallow for the manufacture of candles. The cream of lime used in this process being added gradually in the same manner as the alkaline ley in the manufacture of soap. The fatty materials do not require boiling in these processes, but are kept dissolved at a low temperature by the application of a gentle heat.

The patentee claims producing saponification by mechanical means, without submitting the materials to the boiling process.

Jour. Arts & Science.

*Specification of a patent granted to WILLIAM HOLME HEGINBOTHAM, of the county of Chester, for his invention of certain improvements in the construction of gas retorts.*—[Sealed 31st January, 1838.]

These improvements in the construction of gas retorts consist, firstly, in the introduction of an apparatus into the body of the retort in ordinary use for the distillation of coal, for the purpose of propelling the coal through the retort, and discharging the coke from the same after carbonization. This apparatus is composed of a central shaft passing entirely through the retort, around which shaft is formed a worm or screw, for the purpose of dividing the interior of the retort into helical partitions or chambers, and thus more effectually exposing the coal under process of decomposition to the action of the heated surfaces of the retort; and, secondly, in the application of rotary motion to this helical worm or creeper, in order to cause it to propel the coal through the retort and keep it in constant motion; thus constituting a self-acting gas generator, capable of feeding and discharging itself without the necessity of removing the mouth-piece of the retort, and exposing its interior surface to the action of the atmosphere.

This peculiar combination of apparatus will be found to effect the most perfect decomposition of coal, and, at the same time, to improve the quantity and quality of gas produced, as it will be evident that the revolution of the worm shaft in the bed of the heated retort (and of an uniform heat with it) passing progressively through the coal under operation, and at the same

time working or advancing it from one end of the retort to the other, will effect a most perfect and rapid distillation; while the gas evolved will become, as it were, filtered and improved, being freed from tar while effecting its passage to the exit or ascending pipe at the discharging end of the retort.

Another considerable improvement is effected by the revolution of the worm, as it will entirely prevent the interior of the casing or retort from becoming encrusted with coke or other matter to which it is usually subject, thus rendering it more durable; and it will always ensure an uniform regularity in the supply of coal simultaneously with the discharge of coke, and also that no coke will remain in the retort after it has become carbonized. I have attached to these improvements an apparatus to crush or grind the coal prior to its introduction into the improved retort, as its peculiar construction enables me to generate gas from pulverised coal, and, consequently, to produce it at a much less cost. (Figures representing the improved retorts may be seen in Newton's London Journal for February.)

Ibid.

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### Progress of Practical and Theoretical Mechanics and Chemistry.

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Among the works recently received by the Institute from abroad, is a small volume presented by William Vaughan, Esq., of London; entitled, *Arts and Artisans at Home and Abroad: with sketches of the progress of Foreign manufactures.* By JELINGER C. SYMONS, Esq., one of the assistant Commissioners on the hand-loom inquiry, &c.

The subject of this treatise is so germane to the objects of the Institute, and so well calculated to interest the readers of its journal, that we shall from time to time insert copious extracts of the matter of fact details which it contains, and occasionally give the opinions of the author; without, however, any design to subscribe to his views of national policy.

The rates of wages and price of provisions are given in the currency of the nations whose manufactures are examined, and it is deemed proper to leave these unchanged; merely premising that the conversion into federal currency is attained with sufficient accuracy by assuming the penny sterling, (*d.*) equal to two cents; the shilling (*s.*) will consequently be 24 cents, and the pound sterling (*l.*) will be \$4.80.

The Franc of the French, (*fr.*) is nearly 20 cents, the centime (*cent.*) being the  $\frac{1}{100}$  of a franc will equal two mills.

The Florin, (*Fl.*) is about 40 cents, and the Kreutzen, (*Kr.*) is  $\frac{1}{80}$  of the florin or about  $\frac{2}{3}$  of a cent.

COM. PUB.

### *Wages at Home.*

I shall first endeavor to exhibit the exact differences between the rates of wages here and abroad, both as regards their pecuniary and real value. I will begin with this country; and having given a summary sketch of the average wages of journeymen, current in the chief branches of industry here, I shall proceed to detail more circumstantially the wages paid to the same artisans in some of the chief nations of the Continent. I believe, allowing for the fluctuations of trade, the following statement will be found sufficiently accurate for the purposes of comparison.

The following rates of wages in the Lancashire Factories are nearly an



average for the whole country, and were drawn up by the Manchester Chamber of Commerce:

|                            |   |   |       |    |       |
|----------------------------|---|---|-------|----|-------|
| Spinners, men,             | . | . | 20s   | to | 25s   |
| Spinners, women,           | . | . | 10s   |    | 15s   |
| Stretchers,                | . | . | 25s   |    | 26s   |
| Piecers, (boys and girls,) |   |   | 4s 7d |    | 7s    |
| Scavengers,                | . | . | 1s 6d |    | 2s 8d |

*In the Card room:*

|                    |   |   |        |  |       |
|--------------------|---|---|--------|--|-------|
| Men,               | . | . | 14s 6d |  | 17s   |
| Young women,       | . | . | 9s     |  | 9s 6d |
| Children,          | . | . | 6s     |  | 7s    |
| Throstle spinners, |   |   | 5s     |  | 9s 6d |
| Reelers,           | . | . | 7s     |  | 9s    |

*Weavers by Power:*

|                      |   |   |     |  |         |
|----------------------|---|---|-----|--|---------|
| Men,                 | . | . | 13s |  | 16s 10d |
| Women,               | . | . | 8s  |  | 12s     |
| Dressers, men,       | . | . | 28s |  | 30s     |
| Winders and warpers, | . | . | 8s  |  | 11s     |
| Mechanics,           | . | . | 24s |  | 26s     |

*Weaving by Hand:*

| Quality          | Woven by          |     |       |
|------------------|-------------------|-----|-------|
| Nankeens, fancy, | men,              | 9s  | 15s   |
| " common,        | children & women, | 6s  | 8s    |
| " best,          | men,              | 10s | 13s   |
| Checks, fancy,   | men,              | 7s  | 7s 6d |
| " common,        | children,         | 6s  | 7s    |
| Cambrics,        | all ages,         | 6s  | 6s 6d |
| Quiltings,       | men and women,    | 9s  | 12s   |

In other trades, the following are about the average rates of wages paid throughout England:

|                         |            |       |          |     |
|-------------------------|------------|-------|----------|-----|
| Fustian cutters,        | all ages,  | 10s   | to       | 12s |
| Machine makers,         | men,       | 26s   |          | 30s |
| Iron founders,          | men,       | 28s   |          | 30s |
| Dyers and dressers,     | men,       | 15s   |          | 20s |
| "                       | young men, | 12s   |          | 14s |
| "                       | boys,      | 5s    |          | 10s |
| Tailors,                | men,       | 18s   |          | 20s |
| Porters,                | "          | 14s   |          | 16s |
| Shoemakers,             | "          | 15s   |          | 18s |
| Whitesmiths,            | "          | 22s   |          | 24s |
| Sawyers,                | "          | 24s   |          | 28s |
| Carpenters,             | "          | 20s   |          | 25s |
| Stone-masons,           | "          | 18s   |          | 22s |
| Bricklayers,            | "          | 17s   |          | 20s |
| Bricklayers' labourers, | "          | 12s   |          |     |
| Painters,               | "          | 18s   |          |     |
| Slaters,                | "          | 3s 8d | per day. |     |
| Plasterers,             | "          | 19s   | to       | 21s |
| Spadesmen,              | "          | 10s   |          | 15s |
| Blacksmiths,            | "          | 18s   |          | 22s |
| Compositors,            | "          | 24s   |          |     |

Wages in Sheffield vary from 25*s.* to 35*s.* per week for the workmen in the skilled departments and often amount to 40*s.* per week.

In the iron-works in the Birmingham district, wages average from 20*s.* to 30*s.* for the common labourers, so great is the increasing demand in the iron trade.

In the Leeds flax-mills the wages average as follows:—Male adults, from 17*s.* to 19*s.* per week; females from 5*s.* 6*d.* to 6*s.* 6*d.*; children between nine and ten years old, 3*s.* 6*d.* to 4*s.*

In the Gloucestershire cloth-factories, the wages of male adults average from 12*s.* to 14*s.*; of females, from 4*s.* to 5*s.*, and of children, from 2*s.* to 3*s.* 6*d.*

To these I may add the following statements as regards Scotland, where my inquiries were personally applied.

In and near Glasgow, masons, bricklayers, house-carpenters, blacksmiths, &c., earn from 19*s.* to 22*s.* per week. Engineers from 20*s.* to 30*s.*, according to skill, &c.; and some higher. Tailors, cabinet-makers, hatters, plumbers, shoemakers, &c., earn from 20*s.* to 25*s.* In the country the wages are lower by 10 to 20 per cent. In the cotton-mills the following may be taken as a fair general average:

|                                                     | Per week.               |
|-----------------------------------------------------|-------------------------|
| Picking room, females 20 years of age and upwards,  | 7 <i>s.</i>             |
| Attending cards, males and females, 13 years to 15, | 4 <i>s.</i> 6 <i>d.</i> |
| “ drawing frames, females, 16 years and upwards,    | 6 <i>s.</i> 6 <i>d.</i> |
| “ slobbering frames, do. do.                        | 6 <i>s.</i> 6 <i>d.</i> |
| “ finishers, do. do.                                | 7 <i>s.</i>             |
| “ stretchers, do. do.                               | 8 <i>s.</i> 6 <i>d.</i> |
| “ throstle spinners, do. 13 years and upwards,      | 7 <i>s.</i>             |
| “ reelers, do. 16 years and upwards,                | 6 <i>s.</i> 6 <i>d.</i> |
| “ toppers, males, 20 years and upwards,             | 14 <i>s.</i>            |
| “ spinners, do. do. 25 <i>s.</i> to 29 <i>s.</i>    |                         |
| “ outside piecers, do. 16 years to 20               | 6 <i>s.</i>             |
| “ inside piecers, do. 13 years to 16                | 3 <i>s.</i> 6 <i>d.</i> |
| “ cleaners, do. 9 years to 13                       | 2 <i>s.</i>             |

In Lancashire, nearly the same distribution of labour prevails; but the average rate of wages, including men, women, and children, indiscriminately, amounts weekly to 10*s.* 6*d.* per head.

In the collieries, the following table affords a views of the variations which have taken place in wages since 1811; and as no trade has been more subject to combinations, or exhibited more important peculiar features, I do not hesitate to introduce it. I am indebted to William Dixon, Esq., one of the largest proprietors of collieries in Great Britain, for the information it contains.

|              | Average earnings per day. |    |    | Average Earnings per week, assuming $4\frac{1}{2}$ days of 10 hours as the average quantity of work wrought by each collier per week, with house free, and coal free, except his own labour in producing it. |    |                 | Total earnings per week including house-rent, which is given gratis, and coals. |    |                 |
|--------------|---------------------------|----|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----------------|---------------------------------------------------------------------------------|----|-----------------|
|              | L.                        | S. | D. | L.                                                                                                                                                                                                           | S. | D.              | L.                                                                              | S. | D.              |
| 1811         | 0                         | 4  | 11 | 1                                                                                                                                                                                                            | 2  | $1\frac{1}{2}$  | 1                                                                               | 4  | $8\frac{1}{2}$  |
| 1812         | 0                         | 4  | 11 | 1                                                                                                                                                                                                            | 2  | $1\frac{1}{2}$  | 1                                                                               | 4  | $6\frac{1}{2}$  |
| 1813         | 0                         | 4  | 0  | 0                                                                                                                                                                                                            | 18 | 0               | 1                                                                               | 0  | 5               |
| 1814         | 0                         | 4  | 3  | 0                                                                                                                                                                                                            | 19 | $1\frac{1}{2}$  | 1                                                                               | 1  | $5\frac{1}{2}$  |
| 1815         | 0                         | 4  | 6  | 1                                                                                                                                                                                                            | 0  | 3               | 1                                                                               | 2  | 5               |
| 1816         | 0                         | 4  | 7  | 1                                                                                                                                                                                                            | 0  | $7\frac{1}{2}$  | 1                                                                               | 2  | 9               |
| 1817         | 0                         | 4  | 0  | 0                                                                                                                                                                                                            | 18 | 0               | 0                                                                               | 19 | 11              |
| 1818         | 0                         | 3  | 8  | 0                                                                                                                                                                                                            | 16 | 6               | 0                                                                               | 17 | 5               |
| 1819         | 0                         | 3  | 11 | 0                                                                                                                                                                                                            | 17 | $7\frac{1}{2}$  | 0                                                                               | 19 | $6\frac{1}{2}$  |
| 1820         | 0                         | 3  | 9  | 0                                                                                                                                                                                                            | 16 | $10\frac{1}{2}$ | 0                                                                               | 18 | $9\frac{1}{2}$  |
| 1821         | 0                         | 3  | 3  | 0                                                                                                                                                                                                            | 14 | $7\frac{1}{2}$  | 0                                                                               | 16 | $6\frac{1}{2}$  |
| 1822         | 0                         | 3  | 6  | 0                                                                                                                                                                                                            | 15 | 9               | 0                                                                               | 17 | 10              |
| 1823         | 0                         | 3  | 7  | 0                                                                                                                                                                                                            | 16 | $1\frac{1}{2}$  | 0                                                                               | 18 | $1\frac{1}{2}$  |
| 1824         | 0                         | 4  | 2  | 0                                                                                                                                                                                                            | 18 | 9               | 1                                                                               | 0  | 0               |
| 1825         | 0                         | 5  | 3  | 1                                                                                                                                                                                                            | 3  | $7\frac{1}{2}$  | 1                                                                               | 6  | $5\frac{1}{2}$  |
| 1826         | 0                         | 5  | 0  | 1                                                                                                                                                                                                            | 2  | 6               | 1                                                                               | 4  | 8               |
| 1827         | 0                         | 4  | 3  | 0                                                                                                                                                                                                            | 19 | $1\frac{1}{2}$  | 1                                                                               | 0  | $9\frac{1}{2}$  |
| 1828         | 0                         | 4  | 3  | 0                                                                                                                                                                                                            | 19 | $1\frac{1}{2}$  | 1                                                                               | 0  | $11\frac{1}{2}$ |
| 1829         | 0                         | 4  | 3  | 0                                                                                                                                                                                                            | 19 | $1\frac{1}{2}$  | 1                                                                               | 0  | $9\frac{1}{2}$  |
| 1830         | 0                         | 4  | 3  | 0                                                                                                                                                                                                            | 19 | $1\frac{1}{2}$  | 1                                                                               | 0  | $11\frac{1}{2}$ |
| 1831         | 0                         | 3  | 11 | 0                                                                                                                                                                                                            | 17 | $7\frac{1}{2}$  | 0                                                                               | 19 | $3\frac{1}{2}$  |
| 1832         | 0                         | 4  | 1  | 0                                                                                                                                                                                                            | 18 | $4\frac{1}{2}$  | 1                                                                               | 0  | $0\frac{1}{2}$  |
| 1833         | 0                         | 4  | 0  | 0                                                                                                                                                                                                            | 18 | 0               | 0                                                                               | 19 | 8               |
| 1834         | 0                         | 4  | 0  | 0                                                                                                                                                                                                            | 18 | 0               | 0                                                                               | 19 | 9               |
| 1835         | 0                         | 4  | 0  | 0                                                                                                                                                                                                            | 18 | 0               | 0                                                                               | 19 | 9               |
| 1836         | 0                         | 4  | 9  | 1                                                                                                                                                                                                            | 1  | $4\frac{1}{2}$  | 1                                                                               | 3  | $8\frac{1}{2}$  |
| 1837         | 0                         | 5  | 0  | 1                                                                                                                                                                                                            | 2  | 6               | 1                                                                               | 5  | 0               |
| 1838         | 0                         | 4  | 6  | 1                                                                                                                                                                                                            | 0  | 3               | 1                                                                               | 2  | 7               |
| In July 1838 | 0                         | 3  | 6  | 0                                                                                                                                                                                                            | 15 | 9               | 0                                                                               | 17 | 5               |

The stocking-makers of Leicester average, according to Mr. Porter's statement, 8s. 3d. per week. In Dumfries, celebrated for the excellency of this article of manufacture, the workmen are paid at so much per dozen of the fabric woven, whether stockings, drawers, or shirts. Men's stockings of 24 gage are paid 9s. 6d. per dozen, and an average workman will make 18 pair in the week; gross wages 14s. 3d. from which deductions for frame rent and seaming amount to 2s. 2d. leaving 12s. 1d. clear wages; and this may be considered an average rate of wages in this trade.

Almost all the above named trades are more or less combined.

Of those trades which are not combined, or where the unions, if existing at all, are inefficient, that of hand-loom-weaving is the chief.

In Scotland, which may be taken as a tolerably fair average of other parts of the kingdom, and where I found 51,000 hand-loom south of the Forth



and Clyde, the following is an outline of the average net wages earned on gingham and pullicates, or checked handkerchiefs, and muslins, comprising a very great majority of the whole number of looms. The weavers earn from 4s. 6d. to 7s. net wages and by far the largest portion of them under 5s net, after the expenses they incur, varying from 1s. 2d. to 1s. 6d. are defrayed. On fancy muslins, silk gauzes, and the commoner description of shawls, employing a small number of looms, compared with the foregoing, the wages vary from 5s. to 8s. per week, net. On the finer description of Paisley and Edinburgh shawls, from 9s. to 14s are earned; but where fancy patterns, involving considerable complexity in the mountings of the loom, are required, it is hardly possible to fix an average. Great skill, and sometimes the success of a particular pattern in a market, capricious and uncertain like that of fashion, will afford the skilled weaver 20s., 25s., and 30s per week; but these may be almost regarded as prizes in a lottery, and are as little reducible to calculation. The woollen weavers, of whom there are but few, and those isolated in particular localities, are well paid in Scotland, earning from 10s to 20s. per week.

The woollen weavers work almost entirely in factories where the hand-loom is placed, belonging to the manufacturer; and I ought to have stated above, that in the few instances where this is the case with the gingham, checks, and other cotton fabrics, the wages are invariably from 40 to 80 per cent higher. To this singular feature I shall have occasion to refer hereafter. I subjoin a table, shewing the extraordinary decline of hand-loom wages during the last thirty years, in one of the chief trades.

*Pullicates and Gingham.*

| Period.      | Average net weekly wages. |            | Period. | Average net weekly wages. |            |
|--------------|---------------------------|------------|---------|---------------------------|------------|
|              | 1st Class.                | 2nd Class. |         | 1st Class.                | 2nd Class. |
| 1810 to 1816 | 17s                       | 24s 6d     | 1830    | 6s                        | 7s 6d      |
| 1816 to 1820 | 10s                       | 13s 5d     | 1831    | 6s                        | 7s 6d      |
| 1821         | 8s 6d                     | 12s 2d     | 1832    | 5s 9d                     | 7s         |
| 1822         | 9s 6d                     | 12s 2d     | 1833    | 5s 3d                     | 6s 6d      |
| 1823         | 9s 6d                     | 12s 2d     | 1834    | 6s 6d                     | 7s 3d      |
| 1824         | 9s 6d                     | 12s 2d     | 1835    | 6s 8d                     | 7s 9d      |
| 1825         | 7s 6d                     | 10s        | 1836    | 5s 9d                     | 7s 6d      |
| 1826         | 6s 6d                     | 8s 2d      | 1837    | 4s 3d                     | 6s 6d      |
| 1827         | 7s 6d                     | 10s        | 1838    | 4s 6d                     | 7s         |
| 1828         | 6s 6d                     | 8s 5d      | 1839    | 5s                        | 7s 6d      |
| 1829         | 6s 6d                     | 8s         |         |                           |            |

Agricultural wages, which, though not strictly within the scope of my subject, I was at some pains to collect in Scotland; and as the following were derived almost exclusively from official sources, they may be worth recording, especially as the economy of agriculture in Scotland differs considerably from that of England.

I select some of the most important agricultural counties of Scotland.

“In *Kincardineshire*, married male servants are generally engaged by the year, from Whitsunday to Martinmas; and, in addition to the average

rate of wages, 12*l.* 12*s.* 10 per annum, and 17½ *lb.* of oatmeal per week, they have, in most parts of the county, a house and garden, with, in some places, 1½ pint of new milk per day, or 4 gallons of new milk per week, 2 bolls of potatoes, or ground properly prepared, which will grow  $\frac{3}{4}$  of a ton of potatoes, and ten barrels of coals. Where the employer gives the milk of a cow, the money wages may average 10*l.* 10*s.*, and the other items are given him.

"The diet and other allowances given to the married male servant, exclusive of money-wages, have been estimated by intelligent agriculturists at 14*l.* to 16*l.* per annum.

"Unmarried male servants are generally engaged for the half year; and in most cases they have an allowance of 17½ *lb.* of oatmeal, and 3 gallons of new milk weekly, with a bed, and an apartment to cook in, and an allowance of fuel and light; or they get their victuals in the farmer's ouse.

"Board-wages for men are 3*s.* 6*d.* per week; and the diet, &c. exclusive of money-wages, have been estimated at 12*l.* 4*s.* 5*d.* per annum.

"Married female servants are very seldom engaged by the half-year: they are almost always engaged by the day, or at piece work, such as hand-hoeing of green crop, &c., and earn per day, without diet, 8*d.*; at hand-hoeing green crop, 1*s.*; and at harvest-work, 2*s.* 6*d.* per day at piece work.

"Unmarried female servants are generally hired by the half year, but are likewise hired by the whole year, at the average rate of 5*l.* 16*s.* 6*d.* per annum of wages, and are generally allowed washing, but not always.

"Board-wages for women are 2*s.* 6*d.* per week; and their diet, &c. exclusive of money-wages, have been estimated at 10*l.* 8*s.* 6*d.* per annum.

"Boys are hired as young as twelve years of age, and are reckoned boys until they can manage a pair of horses.

"Board-wages for boys are 2*s.* 6*d.* per week; and their diet, &c. exclusive of money-wages, have been estimated at 9*l.* 19*s.* per annum.

"Girls are not generally hired as agricultural labourers by the half year. They are employed as day-labourers, at 8*d.* per day, without diet. For hand-hoeing green crop, or hired as harvest-labourers, a girl of seventeen years of age will get the average rate of harvest-wages allowed to unmarried female servants.

"Board-wages for girls is 2*s.* per week; and their diet, &c. exclusive of money wages, have been estimated at 9*l.* 4*s.* 5*d.* per annum.

"The rate of wages given to day-labourers supposes an average rate for the year.

"The diet, &c. to harvest-labourers have been estimated for men at 1*l.* 17*s.* 6*d.*, and for women at 1*l.* 13*s.* 9*d.*, for six weeks.

"In *Dumfriesshire*, the wages of ploughmen average 1*s.* 6*d.* per day, with bacon, potatoes, oatmeal, and milk. Boys of twelve and upwards, 4*s.* Able-bodied men, wages per half year, 5*l.* 15*s.*; women, 2*l.* 15*s.*, with board. Agricultural labourers, summer half year, 18*d.* per day of ten hours; winter half year, 15*d.* per daylight to dark, without victuals. Cottages and garden, 50*s.* per year.

"*Roxburghshire*, ordinary labourers, 10*s.* 6*d.*

"Hinds or ploughmen paid wholly in money, and including house-rent, 11*s.* 9½*d.*

"Hinds or ploughmen paid partly in money, and in kind, viz., portions

of meal, barley, and pease, potatoes planted, and cow maintained, and also including house rent, 12s. 5½d.

“Shepherds paid in kind, and also including house rent, 12s. 9½d.

“Women’s wages, from first March to first December, 5s.

“Do. from first December to first March, 4s.

In *Perthshire*, ploughmen’s wages for a twelvemonth, money, 13l.; 1 pint sweet milk per day, a 3d., 4l. 11s. 3d.; two pecks oatmeal per week, a 1s., 5l. 4s.,

“Lodging, say at the rate of 1s. per week, . . . . . 2l. 12s. 0d.

25l. 7s. 3d.

“Day or week labourers are paid during the winter months at the rate of 8s. per week; and in summer, at the rate of 11s. per week; in all, say 24l. 14s.

“In *Fifeshire*, 1. An overseer who takes a small part in the manual labour of the farm, and at same time oversees and directs the other servants, earns 15s. 2d. per week.

“2. A foreman or overseer who joins in all the manual labour, and at the same time directs the operations of the other servants on the farm under him, earns 11s. per week.

“3. Servants under any of the foregoing, who are married, and have a house and cow’s grass, and other perquisites, earn 9s. 1d. per week.

“4. Servants who live in a bothie, furnished by the farmer, who have part meal, part money wages, with fire to make ready their victuals, 8s. 3d. per week.

“*Note.*—All farm servants are engaged to labour from six in the morning to six at night, and thereafter to feed and do up their horses.

“5. Workmen employed on farms making drains, scouring ditches, and others who have a fixed daily wage in money commonly called day labourers, 10s per week.

“*Note.*—This class of labourers work from six in the morning to six at night, but are frequently interrupted from work by inclement weather, particularly in winter, in which event they are only paid for the number of days or hours they are employed in working.

Agricultural wages in England vary so little and are so well known, that I need hardly do more than state that in the Cotswold districts, for instance, a shepherd receives 10s. weekly, a carter the same, day labourers 8s. in summer and six in winter, in addition to which, they earn about three guineas at harvest time, which will pay their rent. Women receive 6d. a day in winter, 8d. in summer, and 1s. in time of hay and harvest time. Perhaps these are the lowest wages paid in any district in England. From 8s. 6d. to 10s. 6d. will be throughout the average wages of the great bulk of adult male agricultural labourers of England.

As no estimate of mere pecuniary wages is of any practical use without a knowledge of their real value, I subjoin an average of the prices of provisions in the manufacturing districts of England and Scotland, which will be found as nearly correct as any general average can be made. It refers to the last two or three years *before* the recent rise of the price of grain.

#### *England.*

|                    |     |                         |         |
|--------------------|-----|-------------------------|---------|
| Best beef, per lb. | 6d. | Coarse beef per lb.     | 3½d.    |
| Bacon, . . . . .   | 7d. | Bread flour, per 12 lb. | 2s. 6d. |



|                        |         |                                   |          |
|------------------------|---------|-----------------------------------|----------|
| Wheaten flour, per lb. | 2d.     | Cheese, . . . .                   | 7d.      |
| Malt, per 9 lb.        | 2s. 4d. | Potatoes, per 252 lb.             | 3s. 6d.  |
| Pork, per lb.          | 6d.     | Coals, p. ton (without carriage,) | 10s. 6d. |

In Scotland the following have been the average prices of meal, &c. in the last few years.

|                              |           |           |
|------------------------------|-----------|-----------|
| <i>Perthshire</i> —          | 1834.     | 1836.     |
| Oatmeal, per boll of 140 lb. | 14s. 5d.  | 21s. 5d.  |
| Best wheat, per Imp. qr.     | 44s.      | 52s. 1d.  |
| <i>Edinburgh</i> —           |           |           |
| Oatmeal, per boll,           | 11s. 10d. | 17s. 2½d. |
| Best wheat, per Imp. qr.     | 40s. 8d.  | 54s.      |
| <i>Dumfries</i> —            |           |           |
| Oatmeal, per boll,           | 13s. 6½d. | 20s. 10d. |
| Best wheat, per Imp. qr.     | 40s. 10d. | 52s. 10d. |

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*Wages in Belgium, and Physical condition of the Artisans.*

Having summarily sketched, in the foregoing pages, the rates and variations of wages in the chief departments of home industry, I shall, ere I offer any remark on the features they exhibit, proceed to give as detailed a view of wages on the Continent as the relative importance of each country requires. I may state, that by very far the greater part of these returns are derived from official sources, on which implicit reliance may be placed, and which I was at great pains to corroborate or correct by personal inquiries, with the facilities to which I have already alluded. The returns from Wirtumberg, Holland, and partially from Prussia, are mostly derived from the "foreign communications," collected by the Commissioners of Inquiry into the State of the Poor Laws, and of which I have availed myself, for the purpose of rendering the following sketch of continental wages as complete as it could be rendered. Unless otherwise stated, the period at which the wages were struck, is last year.

Owing to the great facilities afforded me through Her Majesty's minister at Brussels, and the introductions he kindly procured me, I am enabled to state the wages in Belgium with considerable detail; and I am bound, moreover, to tender my best acknowledgments to Monsieur Vandermaelen, the celebrated geographer and statist of Brussels, for his courteous and efficient aid. I need hardly add, that, from her peculiar territorial and maritime advantages, her mineral riches, and the laborious character of her artisans, and the enterprise of her manufacturers and merchants, Belgium is perhaps, of all other neighbouring countries, the one whose commercial and industrial progress is the most interesting to Englishmen.

The main sinew of Belgian prosperity is unquestionably her iron. I shall commence therefore, with the wages paid in the various departments of the iron manufacture.

One of the largest establishments in the world for the manufacture of machinery, is that of Mr. John Cockerill, of Seraing, who is, moreover, at the head of 53 distinct establishments, including mines, spinning and weaving factories, &c. At Seraing near Liege, 3000 workmen are employed. The wages are as follows:—The designers (*dessinateurs*) receive from 1500

to 2000 francs\* per annum, or 60*l.* to 80*l.* The workmen are divided into brigades. There are 40 in the first process who earn from 3 to 4 fr. per day; the overseer is an Englishman with a fixed salary. The founders earn from 4 to 5 fr. per day. The nail-makers are 200 in number, chiefly very young men, who are paid per weight of nails, and earn from 3 to 4 fr., being responsible for losses. The manufacture of furnaces is very considerable, from 500 to 600 workmen are employed, earning from 4 to 5 fr.: this work is very laborious, and deafens most of the men. The forgers earn various wages; from 2.50 to 6 frs. In the higher skilled and more laborious departments, wages vary from 5 to 10 frs. per day. In the collateral workshops, all comprised in the establishment, there are 60 carpenters (model makers,) who earn  $\approx$  fr. 40 cent., also, leather workers, at from 2 to 3 fr. per day; the out-door carpenters earn the same. There are 500 turners in wood, brass, and iron, who earn, for the most part, from 2 to 3 fr. per day, and the older ones double. There are 400 fitters and filers, who earn from 2 to 3 fr. per day, and divide a perquisite of 70 florins according to the work they have done. The proving department (*l'Atelier d'epreuve*) is composed of the oldest and most experienced workmen, who earn from 4 to 5 fr. a day. The assistants mostly youths, earn from 1 fr. 50 cent. to 2 fr. per day. There are not above 6 or 7 English engineers now in the establishment, who earn from 10 to 15 fr. per day, and who are each superintendents of different departments.

The average wages of the adult workmen in this leviathan establishment, are about 3 fr. 50 cent. The others in Belgium may be taken at about 10 per cent. lower. The ordinary hours of labour are 11 per day. The *miners* gain as follows:—

|                          |   |                         |
|--------------------------|---|-------------------------|
| The superintendents,     | - | 2 fr. 30 cent. per day. |
| The first class workmen, | - | 2 fr. 25 cent. “        |
| Second do.               | - | 2 fr. 10 cent. “        |
| Youths,                  | - | 1 fr. 90 cent. “        |
| Do. under 12             | - | 1 fr. 30 cent. “        |

Age of admission is 10 years. Period of work, usually six hours per day.

N. B. The food of these workmen is usually pork, and bacon, and potatoes. Coffee and gin are their ordinary beverage. The workmen on the surface earn from 2 fr. to 2 fr. 50 cent.

“The two pound loaf, of the quality of bread usually eaten by the lower classes at Brussels, costs 32 cent. ( $3\frac{1}{4}d.$ .) and it would probably be less dear elsewhere; from what I could learn at Liege, the expenses of living are little more than two-thirds of what they are at Brussels, but this may be attributed to the extreme cheapness of vegetables which form a principal article of consumption for the poor.

In cotton-spinning factories, the chief of which are at Ghent, the general rate of wages are—

|                                   |                                  |
|-----------------------------------|----------------------------------|
| For adult men, spinners, &c. from | 2 fr. 50 cent. to 3 fr. per day. |
| For apprentices from 12 to 16,    | 75 cent. to 1 fr. “              |
| For girls,                        | 75 cent. to 1 fr. “              |

\*I shall use the money of the country; a franc is nearly equivalent to tenpence, and is divided into 100 centimes, of which every ten are worth about one penny. Twenty-five francs 25 centimes make a pound sterling.

The following are the wages which I struck from Mons. de Bast's factory:—

135 weavers were paid 1800 fr. per week for 14 hours' work per day, making an average of 13 fr. 33 cents, each per week.

In the spinning mill 143 persons are paid 1400 fr. per week, making an average of 9 fr. 79 cent. per week.

A good spinner will earn 24 fr. per week, out of which he has 7 fr. 50 cent. to pay to his piecer; spinners are paid 23 to 25 cent. ( $2\frac{1}{4}d.$  to  $2\frac{1}{2}d.$ ) per kilogramme,  $2\frac{1}{3}$  lb.

During six months last year, Monsieur Bast's mill worked 1950 hours, or 13 hours daily, reckoning 150 working days in the half year. Just then I was assured they worked from 14 to 15 hours. However this may be, the people in the mills, especially the females, looked exceedingly well; and a gentleman who had seen mills in Scotland, and was with me, was also of opinion that the people in the Ghent mills looked quite as well as those he had seen in Scotland.

Another cotton spinner writes: "I have several spinners who employ an equal number of little girls, though the number will soon be augmented. These spinners gain about 17 fr. per week, out of which they have to pay 2 or 3 fr. to those children who assist them.

In the linen spinning factories the men are paid at the rate of 1 fr. 35 cent. for every 12 hours' work. No women are as yet employed in these factories, though the want of more hands will probably introduce them ere long. The children employed are about one-quarter the number of the men.

In the woollen spinning factories the wages are nearly the same as in the cotton factories.

In the dyeing establishments of forty work people, the following were the wages,

|    |   |        |     |     |    |       |     |      |
|----|---|--------|-----|-----|----|-------|-----|------|
|    | 5 | earned | 2   | fr. | 20 | cent. | per | day. |
| 15 | " | 1      | fr. | 80  | "  | "     | "   | "    |
| 5  | " | 1      | fr. | 60  | "  | "     | "   | "    |
| 5  | " | 1      | fr. | 40  | "  | "     | "   | "    |
| 5  | " | 1      | fr. | 20  | "  | "     | "   | "    |
| 5  | " | 0      | fr. | 80  | "  | "     | "   | "    |

No females are usually employed in these works.

The following is a summary of the rates of labour in town and country, in the other chief arts and trades:—



| Trades.                                     | Town Wages. |     | Country Wages.              |     | Hours usually worked. |
|---------------------------------------------|-------------|-----|-----------------------------|-----|-----------------------|
|                                             | fr.         | ct. | fr.                         | ct. |                       |
| Masons, Carpenters, and }<br>Blacksmiths, } | 2           | 5   | 1                           | 60  | 11½                   |
| Day-labourers, - - -                        | 1           | 35  |                             |     | 11½                   |
| Saddlers, - - -                             | 2           | 25  |                             |     |                       |
| Wheelwrights, - - -                         | 2           | 25  |                             |     |                       |
| Compositors, - - -                          | 3           | 0   |                             |     |                       |
| Lithographic Printers, -                    | 5           | 0   |                             |     |                       |
| Cabinet Makers, - - -                       | 3           | 0   |                             |     |                       |
| Bleachers, - - -                            |             |     | 2                           | 0   | 16 in summer.         |
| Tailors and Shoemakers,                     | 2           | 50  | { 1 60 }<br>or with food 75 |     | 11 to 12              |
| Sawyers, - - -                              | 3           | 25  |                             |     |                       |
| Forgers, - - -                              | 6           | 0   |                             |     |                       |
| Coach Painters, - - -                       | 2           | 25  |                             |     |                       |
| Paviors, - - -                              | 1           | 80  |                             |     |                       |
| Labourers at Canal wharfs,                  | 1           | 70  |                             |     |                       |
| Miners, - - -                               |             |     | 2                           | 50  | 10                    |

Agricultural labourers are paid as follows:—

| Provinces.        |   | Conditions.          |   | Men. |     | Women. |     |
|-------------------|---|----------------------|---|------|-----|--------|-----|
|                   |   |                      |   | fr.  | ct. | fr.    | ct. |
| Brabant,* - - -   | } | { with food - - -    | - | 0    | 63  | 0      | 31  |
| Westpeller, - - - |   | { without food - - - | - | 0    | 91  | 0      | 80  |
| West Flanders, -  | } | { with food - - -    | - |      |     |        |     |
|                   |   | { without food - - - | - | 1    | 20  | 0      | 80  |
| Liege, - - -      | } | { with food - - -    | - | 1    | 18  | 0      | 88  |
|                   |   | { without food - - - | - |      |     |        |     |
| Luxemburg, -      | } | { with food - - -    | - |      |     |        |     |
|                   |   | { without food - - - | - | 1    | 0   | 0      | 85  |

The wages of agricultural labourers vary considerably in East Flanders; they are still lower than in West Flanders, where there are more factories. In Liege and Namur, in the heart of the manufacturing district, agricultural wages are nearly double what they are in the purely agricultural provinces. In the province of Liege it appears that owing to the great demand for hands in the coal and iron works, farm-labourers receive more wages with board than they receive in Luxemburg without it.

The food of the working classes, not only of Belgium, but of all the countries of the Continent, consists of vegetables; meat is not the food of the working classes, either of Belgium or of any other country. It is the relish used with food. The Italian eats macaroni; the staple food of the French and Germans is bread or cabbage; of the Irish, potatoes, (and the consumption of potatoes, as a main article of sustenance, is by no means confined to the United Kingdom, but is rapidly spreading over the Continent.) It is a beautiful fiction to describe John Bull as eating beef. If "John Bull" means two-thirds of the population, John Bull is living on vegetable diet; and not above one-third of him is nourished by meat. The

\*N. B.—Shepherds are well paid, and earn 54 francs a year, their board, and thirty sheep, or 272 francs without sheep.

Indians eat rice; the West Indians, yams and bread tree; the Africans dates; in fact, a fraction, and that a very small one, of mankind are carnivorous.

The workmen employed in the iron-works of the Hainault, Liege, and the machine-making factories both of Seraing, Bruxelles, Ghent, &c., live on potatoes and vegetables, with a piece of meat among them, for dinner regularly; coffee of chiccory; and on the Sundays, spirits in moderate quantity. These are the best paid.

The workmen who come under the second class are the masons, blacksmiths, carpenters, &c. of the towns, the woollen factory and domestic weavers, who live nearly in the same manner, but consume either a less portion of meat, or take it only three or four times a-week.

The cotton weavers and factory workmen live less well. Potatoes and vegetable soup form their chief food, with bread half rye and half wheat; coffee and occasionally a glass of spirits, and commonly brown beer, are their beverage. This beer is particularly nasty, but, I believe, wholly free from *coccus indicus*, &c. &c.,—pure malt, hops, water, and salt, ill proportioned, and execrably boiled.

With regard to the prices of food, an able-bodied man will support himself comfortably on 7*d.* per day in Belgium, in the country. Bread, such as labourers eat, is about 1½*d.* per lb. in the country; other food in proportion.

The price of grain was as follows, per hectolitre, or 22 gallons, equal to 2½ bushels.

|               | 1834.           | 1835.          | 1836.           |
|---------------|-----------------|----------------|-----------------|
| Wheat, white, | 13 fr. 19 cent. | 14 fr. 3 cent. | 15 fr. 56 cent. |
| Do. red,      | 14 fr. 53 cent. | 15 fr. 8 cent. |                 |
| Rye, - -      | 8 fr. 41 cent.  | 9 fr. 4 cent.  | 10 fr. 5 cent.  |
| Oats, - -     | 5 fr. 90 cent.  | 6 fr. 57 cent. |                 |
| Potatoes,     | 3 fr. 21 cent.  | 3 fr. 90 cent. |                 |

The cottages of the country, peasants and artisans, are proverbially neat and clean, and so I universally found them; but my visits to the poor districts in Brussels presented a very different result. The houses where the poor live are dirty, close, crowded, and offensive.

TO BE CONTINUED.

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NOTICE FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

*Substance of some New Researches on the Disengagement of Heat by Friction.* By M. BECQUEREL.

Bodies are considered as formed by the union of an infinite number of molecules, or atoms, surrounded by heat which opposes their immediate contact, aside from all theoretical opinions of its nature. When the quantity of it increases or diminishes, the distance between the molecules becomes greater or less, and the volume of the body experiences corresponding variations.

It is admitted also that these same molecules are subjected to an attractive force which tends to bring them together, and which is consequently opposed to the repulsive influence of caloric. Finally a third force is allowed to interfere in the constitution of bodies,—the attraction of each molecule, for the heat which surrounds the neighbouring particles. When

the force of aggregation predominates over the two others, the body remains solid; if the heat increases, a period arrives at which the molecules acquire a certain mobility and the body becomes liquid. Eventually, if the quantity of heat becomes so great as to overcome the force of aggregation, the body assumes the gaseous form. The molecules of bodies being thus held at distances greater or less in proportion to the reciprocal action of heat and attraction, they must be separated by interstitial spaces in which the phenomena of light, heat, affinities and molecular attraction have been shown to operate. It is therefore in these spaces that the imponderable agents incessantly contend with the material principles of bodies.

Heat must act the principal part in this operation; for, according to its intensity and mode of action it produces light, electricity and the play of chemical affinities. It is obvious therefore that the properties of this agent cannot be too carefully studied in its relation to the particles of bodies, if we wish to arrive at a knowledge of its immediate influence in all that concerns natural phenomena of the most elevated order. These considerations have suggested the idea of a series of experimental researches which have led to some new results, which we shall endeavour to point out without going, as far as we might do, into technical details which it might be difficult to render perfectly clear in a rapid lecture.

Take a body at an equilibrium of temperature with the surrounding medium. If, by any cause whatever, this body be agitated so as to cause its molecules to lose their position of natural equilibrium, it is very evident that all the imponderable agents which existed in the intermolecular spaces will be put into motion. A multitude of phenomena would in consequence result, which the philosopher undertakes to analyze by the means which science has placed at his disposal. We shall confine ourselves at first to the effects of heat produced when friction is the mode of agitation made use of.

We know that when two bodies are rubbed against each other, heat and electricity are disengaged; are these two effects, which are concomitant, dependent, or not, upon each other? This we shall speak of hereafter. At present let us confine ourselves to the effects of heat.

All that we know of the production of heat by the mutual friction of two bodies is reduceable to this; the two bodies grow warm, and the quantity of heat emitted is sometimes so considerable as to inflame combustible substances. Thus a wheel turning rapidly on its axis takes fire, and the savage, with an address and dexterity that we are strangers to, inflames pieces of dry wood by rubbing them with great velocity against each other.

In all such cases we are led to the belief that the effect is owing to a vibratory motion of the particles produced by the friction, as the following facts tend to prove.

When an alloy, composed of one part iron and two parts antimony, is subjected to the file, bright sparks are immediately produced, showing that the temperature is increased to incandescence. The flint and steel exhibit the same effects.

Rumford, by boring a cannon placed vertically, obtained heat enough to boil water in a cavity made for the purpose of boiling it. This then is nearly all that we know about the disengagement of heat by friction. We are completely ignorant of the manner in which a body acts in the production of this phenomenon according to its own nature and the condition of its surface.

In order to determine how each substance intervenes, we must find the means of separating all the causes which mask or conceal the effects which



we have in view. Unhappily we cannot accomplish this in a perfect manner. In fact, when we rub two bodies against each other more or less rapidly without breaking the contact between them, there is evidently a transmission of heat from one to the other. The quantity transferred from each of them depends on the conductivity of the substance, on its capacity for heat, and on the state of its surface. On the other hand, the heat disengaged in a body cannot be detected immediately before its transmission into the other body, by means of the common thermometer, inasmuch as its indications are not instantaneous. Nevertheless, it is possible to operate under circumstances which allow us to remove some of the difficulties just alluded to, and we are thus conducted to a series of facts now to be described.

The apparatus for this purpose is composed of a thermometric pile in connection with an excellent multiplier. Its sensibility is such that a difference of about  $\frac{1}{100}$  of a centigrade degree, in the temperature of the two faces of the pile, causes the magnetic needle to deviate so far that the angle becomes appreciable.

To reduce the question as much as possible to its simplest expression, we take two bodies of the same nature, bad conductors of heat, equal in all their dimensions, and differing only in the condition of their surfaces. These bodies are attached to glass rods. The rubbed surfaces are placed each in contact with one of the faces of the pile; when those two surfaces are of the same temperature the magnetic needle remains at rest, since the two thermo-electric currents being equal and in contrary directions destroy each other; but when the temperatures are not the same, the needle deviates immediately and the angle of declination shows the difference of temperature. The friction is produced with a velocity and pressure determined by the aid of a particular construction in order that its intensity may be always known; the two bodies are rapidly separated from each other and experimented with immediately.

The above is the process of manipulation,—we proceed to the results.

We commence with trying the effect produced on the needle by the contact of one of the rubbed surfaces with one of the faces of the pile, an effect arising from the heating of that face.

The experiment proves that whatever be the nature of the rubbed disc, whether it be a conductor or non-conductor of heat, the time required to cause the needle to deviate to a maximum of declination, provided that does not exceed  $60^\circ$ , is always  $10''$ . For deviations from  $60^\circ$  to  $75^\circ$  it is  $9\frac{1}{2}''$ , and from  $75^\circ$  to  $90^\circ$  it is  $9''$ .

The needle then acts in this case like a pendulum, oscillating under the action of gravity within small amplitudes, since the deviations are isochronous; but with this difference, however, that in the pendulum, when the amplitude of oscillation increases beyond a certain limit, the time of the oscillation increases equally; whilst the contrary occurs in the experiments now described; that is to say, the time diminishes as the amplitude increases beyond  $60^\circ$  and as far as  $92^\circ$ . This result is connected with the propagation of heat and electricity in bodies.

Let us now take two bodies of the same nature, equal, and disposed as above described; for example two discs of cork, one of which has a smooth surface and the other a rough one. If we rub them against each other in a determined and regular manner, and present them simultaneously to the two faces of the thermo-electric pile, the needle immediately diverges, and the direction it takes shows that the disc with a rough surface has acquired more heat than the other, and that in proportion to the rapidity of the fric-

tion. The same holds good when we rub a piece of polished glass against another which is unpolished. We have found the former to have gained one-half less heat than the second. Hence we perceive that the absorbing power of bodies exerts an influence on the disengagement of heat in friction. This rule, however, is not general, for white satin gives more heat than black satin which has a greater absorbing power.

When bodies of different natures are experimented with, the following results are obtained: 1st. Polished glass and cork,—the first gains more heat than the second in the proportion of 34 to 5. 2d. Unpolished glass and cork; the relation of temperature is as 40 to 7. 3rd. Silver and cork,—the first is heated more than the second in proportion of 50 to 12. 4th. Caoutchouc and cork,—the temperature of the first to the second is as 29 to 11, and so of others.

From the numerous results we have obtained in the friction of bodies of different natures, we are not able yet to deduce any simple laws on account of the various causes which concur to produce the general effect. It only appears that the nature of bodies, aside from conductivity, exerts an influence which the condition of the surface does not always destroy.

We have thus far found it impossible to ascertain the true cause of this influence which depends on the nature of bodies and probably on the arrangement of their molecules; but it is important to have shown this by experiment because it furnishes us with an additional element, which the theory of heat may hereafter take into view. Now, if we enquire into the relation which exists between the production of heat and that of electricity by the natural friction of bodies, the consequences which flow from recent experiments are these,—the displacement of the parts of the rubbed surfaces always gives place to a disengagement of heat and to a disengagement of electricity, two effects which have a reciprocal dependence; this dependence is so much concealed that it is impossible yet to affirm whether one precedes the other, and *vice versa*; we can only indulge in conjectures upon it, and these would induce us to believe that the heat is derived from electricity, when the bodies are of the same nature, slow conductors of heat, and differ from each other only in the condition of their surfaces: the surface which heat the most acquires negative electricity, and that which gains the least heat, the opposite electricity. When the bodies are different, the effects become very complex, and can be interpreted only by having the results before our eyes.

New facts may allow us to extend to light the relations partially discovered between heat and electricity. Phosphorescence affords this advantage. We know that this phenomenon manifests itself wherever the particles of bodies which are slow conductors of electricity are agitated by percussion, friction, heat, light, the electric shock, and also when decomposed by chemical action. These causes are precisely those which disengage electricity; now, the phenomenon being molecular, the recombination of the electricities disengaged around molecules must give rise to an infinite number of little sparks, the totality of which must produce a glow similar to phosphorescence;—whence we are allowed to infer that phosphorescence has an electric origin.

Of the source of the phosphorescence in the *Lampyrea* and infusoria we are ignorant, and if it proceeds also from electricity the important experiments of M. Ehrenberg will probably inform us. This able physiologist has just completed a careful study of the light emitted in the dark by the infusoria and annelides which render the sea luminous in certain countries,

particularly when a light breeze agitates its surface. Having placed on the porte-object of his microscope some water containing these animalcules, he was astonished to see that the diffused light which surrounded them was no other than the union of a multitude of little sparks which were emitted from all parts of their bodies, and especially from the bodies of the annelides. These sparks, which succeeded each other with great rapidity, had so close a resemblance to those observed in electric discharges, M. Ehrenberg did not hesitate to decide on their identity. He also assured himself that the light emitted is not owing to a peculiar secretion, but rather to a spontaneous act of the animal, and that it becomes manifest whenever it is irritated by mechanical or chemical means, viz. by agitating the water, or pouring in alcohol or an acid. How analogous is this to the torpedo, which throws out its discharges only when irritated? The animalcules also, like the torpedo, renew their discharges after a certain period of repose.

From this similarity of effects, under the same circumstances, can we do any other than conclude that there must be an identity in the cause? Now, in the torpedo, no one doubts, at present, that the cause is electricity; we must, therefore, admit that it is the same thing which produces the phosphorescence of the infusoria and the annelides. It is very remarkable that luminous phenomena, or others which depend on electricity, are so much stronger as the animals are smaller; and it would seem that this profusion of electric fluid emitted solely by beings of an inferior order is destined to supply other functions in beings of a more elevated order.

Is it not allowable to infer, from these facts, as Berzelius and other philosophers have advanced, that the light disengaged in combustion, which gives rise to so great a disengagement of electricity, is also but the result of the discharge of an infinity of minute sparks, produced during the combination of combustible bodies with those which are supporters of combustion?

We perceive then that the relations which connect light, heat and electricity are acquiring, from day to day, a fresh extension, and we learn that these three agents, which preside over the molecular constitution of bodies, are derived, according to all appearances, from a single principle, of an ethereal nature, diffused throughout space and in all kinds of matter.

*Annales de Chimie Mars 1839.*

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*On the Supposed Influence which the Roughness and Polish of Surfaces exerts over the emissive power of Bodies.* By M. MELLONI.

When we subject to measurement, the heat which radiates from a metallic vessel filled with boiling water, one of whose longitudinal sides remains well polished and brilliant, and the other roughened by emery, by the graver or the file, we find the quantity of heat thrown off by the depolished surface to be always superior to that which issues from the brilliant side; the difference sometimes exceeding the proportion of two to one. It is hence inferred that the observed increase of heat is occasioned by the superficial inequalities produced on the roughened side, and consequently that asperities on the surface of bodies, tend to facilitate the emission of their internal heat. I am about to communicate to the Academy a sketch of some researches, which, as it appears to me, plainly show that this supposition is entirely erroneous, and that if the superficial layers evidently contribute to vary the quantity of heat emitted by a hot body, the condition of the surface has no part in the production of the phenomenon.



I may acknowledge that, from the beginning, notwithstanding the authority of great names, the influence of polish in the radiation of caloric, always appeared to me very doubtful. It was said that internal heat experiences the same superficial obstruction in leaving the polished surface as radiant heat does in penetrating it from without. Be it so; but why should those little shining facets, which are produced by scratching, reflect less heat internally, than the polished surface of a single piece? Take a receiver of brass, having two polished sides slightly tarnished by exposure to the air. On one of these sides make a series of parallel furrows, by the graver; the sides of these will certainly be more brilliant than the rest of the receiver, and yet the furrowed surface will emit more heat than the smooth surface. About two years ago I mentioned this objection, and that of some other analogous experiments, to Messrs. Bache, Henry and Locke, distinguished professors of philosophy from the United States of America, then at Paris. At the present time, as the question appears to me to be decided, I shall pass over indirect objections and proceed to the immediate results which lead to the proof of what I am advancing.

I took a cubical vessel of copper whose four faces were well prepared, and soldered upon the angles and edges at the bottom, small spring slides, in such a manner as to press tightly against the sides of the cube plates, two or three lines thick. Then having procured two pair of plates, one of jet and the other of ivory, I applied them to the four sides. Each pair was composed of plates perfectly equal in all respects except in the condition of the external surface, one of which was smooth and brilliant, and the other unpolished and scratched with emery. Measuring with exactness by the thermo-multiplier, the quantities of heat emitted by the two polished faces when the receiver was filled with hot water, and comparing them with that which issued from the corresponding roughened surfaces, I found a difference of only one to two hundredths, and that sometimes on one side and sometimes on the other: the mean of twenty trials gave a variation of scarcely a few thousandths, and which of course was unworthy of notice.

It may be objected that in this experiment we are not certain that the two similar plates, notwithstanding the care taken to maintain their contact with the vessel, were of equal temperatures.—To obviate this objection, I had a little block of marble formed into a cubical vessel, the sides of which were reduced to an exactly equal thickness. One of the external surfaces was left smooth and polished. The second likewise smooth, but tarnished and depolished, the third furrowed in one direction, and the fourth cross furrowed perpendicularly. The vessel when filled with hot water, threw off from the four sides equal quantities of heat.

It appears, therefore, that a more or less irregular condition of the surface has no influence on the emissive power, when the radiating body is not metallic.

I covered with lamp black, one of the faces of my marble vessel, as well as one of the plates of each pair in the previous experiment. Calling the emissive power of lamp black 100, I could easily determine by proportional numbers the emissive powers of ivory, jet and marble: all three were comprehended between 93 and 98. May it not be alleged that if in these substances the influence of depolishing amounts to nothing, it is because their emissive power was near the maximum beyond which an increase was not to be effected, the emissive surface being unable to prevent the issue of its heat; while in the metals, very far from this limit, an alteration in the con-

dition of the surface must necessarily exert all its influence, and become sensible by the great difference in the heat emitted.

Though this reasoning is founded on a pure hypothesis, namely, that lamp black opposes no resistance to surface radiation, and that the emissive power of the three substances may be, on the one hand, far enough from 100 to allow us to appreciate the variation produced, and on the other so energetic that the least proportion of a change occurring in their values would cause them to overleap the whole distance which separates them from this number; nevertheless we will abandon for a moment non-metallic substances, and try to resolve the question by the bodies themselves, with which we first set out.

Copper, zinc, pewter and tinned iron, which, as far as I know, are the only metals that have been employed thus far in experiments on this subject, when exposed to the air, are speedily coated with a slight invisible oxide, but whose presence is manifest from certain electric phenomena.—Now we know that the emissive power is much stronger in oxides than in metal. It may happen then that the scratched surface, presenting to the air a greater number of points of contact, becomes more abundantly oxidated than the polished surface, and thus has its radiating power increased by the simple fact of oxidation, independently of the greater or less regularity of its superficial points having any thing to do in the matter.

To ascertain whether this view of the case is supportable, we have only to operate with gold and platina. To this trial I had recourse; but the abraded surfaces of platina and gold gave me a calorific emission much more abundant than the polished plates of both these metals.

Oxidation, as well as the influence of polish in non-metallic bodies, being then excluded, what is the peculiar alteration in metals which may accompany, in these bodies, the change, more or less extensive, to which their outward coat or layer is subjected? This can be no other, in my opinion, than a change of hardness or density. In fact, jet, ivory and marble are substances in which compressibility is almost completely absent, or at least they do not possess in any sensible degree, the property of retaining, in a stable manner, the modifications of density and hardness which a mechanic force may chance to impress upon them. They are fashioned into plates without the aid of pressure. Metals on the contrary are compressible, and the common sheets so well known in commerce, are, as is well known, produced by the powerful pressure of the hammer or the rolling press. These sheets, as well as wire, are well known to possess greater specific gravity and hardness than cast metal. How do we know that this greater hardness and density are uniformly distributed throughout all points of the mass. Is it not more probable that during the operation of rolling, the surface undergoes a pressure and condensation greater than any other part, and that the resulting sheet is definitively enveloped with a kind of crust of superior density and hardness to the internal layers? This admitted, it is clear that in scratching the surface, we open into portions of less density or hardness. Now in glancing at the tables, which present the radiating power of bodies, we perceive that these powers follow, in general, the inverse ratio of densities. Admitting from analogy that the same law takes place in the various states of condensation of the same substance, we must infer that by making furrows in the surface of a plate we ought to obtain an increase of radiating power. Add to this, that the parts which compose the superficial coating, being disengaged by the subdivision of their mutual contact, must be loosened, and thus acquire by

a diminution of density an emissive power which approaches to that of the more tender layers within.

It follows from this view: 1st, that a polished plate of metal radiates a quantity of caloric increasing in proportion to the diminution of the density or hardness of its layers; 2d, that in cases of the least density or hardness the increase of the radiating faculty, produced by taking off the polish, will be inferior to that obtained by thus treating plates of greater density or more thoroughly encrusted.

It is almost unnecessary to add that in verifying those theoretic views we must not employ an oxidable metal at an elevated temperature, for a plate of this kind of metal has a tendency to increase its emissive power, which varies from one moment to another with the condition of its superficial coating, and the more as these coats become more tender and more divided.

Strong percussion, and a slow passage from the fluid to the solid state, are the two means by which we may vary the density of metallic bodies. I had two plates of very pure silver made by strong hammering, and two others by melting and slow cooling in their moulds of sand. With these I formed a hollow rectangular prism to which I gave a metallic bottom. They were united by soft solder so as not to alter their densities or temper during the operation. The four lateral faces were perfectly polished by pumice stone, or charcoal, without the aid of the hammer or burnisher. One of the melted and one of the forged plates were then well rubbed in one direction with paper coated with coarse emery; the images of objects which appeared very clear and distinct on the polished plates were completely effaced by the rubbing, which rendered them dull and streaked. The silver vase, thus prepared, was filled with hot water. The four lateral faces turned successively to the opening of my thermo-electric instrument produced on the galvanometer the following deviations:

- 10° on the forged polished plate.
- 18° on the forged roughened plate.
- 13.7° on the cast polished plate.
- 11.3° on the cast roughened plate.

In comparing these four results, we find, 1st, that in the polished plates, the cast metal gives about a third more heat than the forged, which demonstrates the influence announced in the case of minor density; 2d, that the effect of roughening, on the two kinds of plates, differs not only in intensity, as was predicted, but in sense (*sens;*) for if the radiating power of the forged silver receives an augmentation of four-fifths by the action of emery, that of the melted silver undergoes, on the contrary, a *loss* of almost a third.

This unexpected fact, which proves in an irrefragable manner the truth of our fundamental proposition, is perfectly explicable on the theory which we had just before developed, for the pressure of a hard body like emery on the tender surface of the melted silver, compresses and condenses to some extent the rubbed particles, and renders the bottom of the furrows on one of the plates harder than the entire surface of the corresponding plates.

I regret having been unable to operate in the same manner on vessels of gold and platina, in which these manifestations, in all probability, would have been exhibited on a more extensive scale, on account of the great dif-



ference of density producible on these two metals by fusion and percussion.

In referring to the early observations of Leslie, we see that the several metallic plates that he employed gave him constantly a greater emissive power when rough and irregular than when smooth and polished. Nothing appeared more natural after this than to admit, in the phenomena of calorific emission, independent of the influence arising from the quality of the superficial layers, a special influence due to their degree of polish, at least with respect to the metals, and these were the conclusions derived from the facts observed by Leslie,—and, nevertheless, this conclusion, apparently so simple and direct in appearance, was considered inadmissible.

This example may serve, on occasion, to moderate the luckless facility with which certain experimenters hasten to put forth in the form of general laws, the consequences resulting from their early observations. It too often suffices, by taking an instrument in hand and employing it in some particular research, to fall upon a new fact; but in pursuing the labour with assiduity, in varying the method of experimenting; analyzing the phenomena under different aspects, it almost always happens that the labour ends in the perception that the novelty was only in appearance, and that the true explanation falls under the truths already classed in science; or, if a new truth finally results from the labour, it is almost always contrary to those pretended general laws which first presented themselves to our minds in a manner so attractive and decisive.

Annales de Chimie et de Phys. Avril, 1839.

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*Notice of various New Reactions determined by Platina Sponge, and considerations of the service which this substance may render to Science. By M. KUHLMANN. (Acad. des Sc. t. 7.)*

I have made a great number of experiments on spongy platina, the principal results of which are:

1. Ammonia mixed with air in passing at a temperature of about 300° on platina sponge, is decomposed, and the azote it contains is completely transformed into nitric acid, at the expense of the oxygen of the air.

2. Cyanogen and air, in like circumstances, give rise to the same acid and to carbonic acid.

3. Ammonia, involved in any saline compound whatever, acts as if it were in a free state.

4. In no case does pure azote combine with free oxygen; but all the compounds of azote, under the influence of platina sponge, pass to the state of nitric acid.

5. The protoxide and deutoxide of azote, hyponitric acid and nitric acid, mixed with a sufficient quantity of hydrogen, are transformed into ammonia by contact with the sponge, and more frequently without the aid of heat; the action becomes so energetic that it often occasions violent explosions. All the azote of these acids passes to the state of ammonia in uniting with hydrogen. An excess of nitric acid produces nitrate of ammonia.

6. Cyanogen and hydrogen furnish ammonia in the state of hydrocyanate.

7. The deutoxide of azote in excess, and olefiant gas, in passing in a heated state on platina sponge, produce, besides water and azote, ammonia united with hydrocyanic and carbonic acids.

8. With the deutoxide of azote and an excess of alcoholic vapour, we ob-

tain ammonia united to hydrocyanic and carbonic acids, accompanied with water, olefiant gas and a deposit of carbon.

9. Free azote does not combine with free hydrogen; but all the compounds of azote were transformed into ammonia by free hydrogen or carbonated hydrogen.

10. In these last reactions, the presence of carbon, in combination with azote or hydrogen, gives rise to hydrocyanic acid.

11. All the metalloids, gaseous or vaporisable, unite without exception with hydrogen, under the influence of spongy platina.

12. The vapours of acetic acid mixed with hydrogen are totally transformed into acetic ether (acetate of ether) and into water at a moderately elevated temperature.

A fact well worthy of remark is, that in substituting platina black for the sponge, the energy of the action is infinitely less in the greater number of cases, contrary to what might have been supposed. This action is null for the production of ammonia, and never does the platina black become incandescent as does the sponge. For the transformation of acetic acid into ether, the action of the platina black, is, on the contrary, more vigorous, and produces it at common temperatures.

These facts are sufficient to show, very evidently, the future importance reserved for divided platina. It may serve in the fabrication, at pleasure, of nitric acid or ammonia with azotized materials, and even of alcohol with vinegar, since acetic ether is, as we know, decomposable by alkalies and water, into alcohol, &c.

*Annales des Mines tom. xv 2 liv.*

#### *On the Oxide of Antimony. By M. JULES BOURSON.*

Berzelius, in his *Traité de Chimie*, tome II. page 496, and even in his new German edition, points out as the means of preparing the protoxide of antimony (*acide antimonique*) to treat the metal by nitric acid and to digest the resulting sub-salt of antimony in several successive waters until the water no longer reddens litmus paper.

The oxide, says Berzelius, then appears in the form of a white powder with rather a dirty aspect.

The characters which are known to distinguish it from the two other compounds of oxygen and antimony, are, to melt at a red heat and then to volatilize.

Having remarked that the oxide prepared by this process possessed none of these characters, I prepared a quantity with more attention, using antimony obtained by reducing the chloride by a zinc plate, thinking by this means to conduct the experiment under more favourable conditions.

I treated a portion of this metal with weak nitric acid, and another with concentrated acid, pursuing the process of Berzelius.

The two products, dried in a water bath, were assayed, comparatively, with oxide prepared by decomposing the chloride by water and washing the precipitate with carbonate of potash. The latter heated on a brick by the blow pipe, promptly melted and immediately volatilized; while the two others neither melted nor volatilized; and in subjecting both to the action of heat in a porcelain retort, they both gave out a great quantity of oxygen without the least trace of nitrous vapour.

By exposing them to a degree of heat just inferior to that which would decompose them, they gave out water, and yielded a product of a fine citron yellow.

These characteristics evidently prove that the process indicated by Berzelius, far from furnishing the oxide of antimony, yields, on the contrary, antimonious acid, and I may add, that by employing antimony divided in the way I have mentioned, and which, by the way, is obtained with great facility, we have an excellent process for preparing that acid.

It is presumable that Berzelius used in this preparation, antimony that could not have been sufficiently pulverized; that the interior parts of the metal could not have been attacked by the nitric acid, and that the product was only a mixture of metallic antimony and antimonious acid; the dirty white colour assigned above to the oxide, supports what I have advanced, and the following experiment tends to confirm it.

I made a mixture of antimony in powder, and of oxide obtained from the reduced metal, and heated it with the blow pipe,—the fusion which began to be observable was due only to the presence of the metal, which by the contact of air was oxidized, and then volatilized. I also treated pulverized antimony in the cold with nitric acid, and the product washed and dried, comporting precisely like those which had been prepared with the reduced metal. By exposure to heat, it emitted only a small quantity of nitrous vapour, but there was no indication of fusion or volatilization.

Annales de Chimie, Jan. 1839.

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*On a New Process for Determining the Carbon in Cast Iron and Steel.*

*By M. V. REGNAULT, Mining Engineer.*

This operation is very easy and may be executed with great exactness by the following process.

Take 5 grammes (= 75 or 80 grains) of cast iron, reduced to filings while the iron is soft, or pulverized in a mortar while most brittle,—mix it with 60 or 80 grammes (= 930 or 1240 grains) of chromate of lead previously melted. Set aside a third or fourth part of this mixture;—add to the remainder 75 grains of chlorate of potash, which contains about the requisite quantity of oxygen to change the iron to a peroxide;—then introduce the triple mixture into a glass tube similar to those used in organic analyses, but not necessarily so long. Next put over this the mixture of iron and chromate of lead which had been reserved;—adapt the tube to the common apparatus of Liebig for organic analysis.

Heat that part of the tube which contains the mixture without chlorate, and when red hot, begin to heat the part containing the chlorate, and advance the heat as the disengagement of gas slackens. In this way the cast iron burns at once almost completely by the oxygen of the chlorate, and a very small portion only of this gas escapes from the tube. The temperature afterwards becoming more elevated, the combustion is completed by the chromate of lead, which, in melting, oxidizes the last portions of the iron.

It is proper to enclose the tube in a wrapper of copper, because towards the conclusion it must be heated so thoroughly as to produce the perfect fusion of the chromate.

The oxidation of the iron is complete, as may be proved by rubbing up the contents of the tube after combustion;—not a particle will be found attracted by the magnet. The analysis is so easily accomplished that it may be finished in less than half an hour.

We may judge of the perfect agreement of the results by the three following analyses, made on the same gray iron obtained by hot air.



|      |           |                           |           |
|------|-----------|---------------------------|-----------|
| I.   | 5 grammes | gave 0.582 carbonic acid. |           |
| II.  | 5 do.     | do.                       | 0.585 do. |
| III. | 5 do.     | do.                       | 0.588 do. |

|         |      |      |      |
|---------|------|------|------|
|         | I.   | II.  | III. |
| Carbon, | 3.22 | 3.23 | 3.25 |

When the iron contains sulphur, not a trace of sulphurous acid is disengaged; the sulphur remains wholly in the tube in the state of sulphate of lead. I have assured myself of this by treating sulphuret of iron by this process.

With chromate of lead alone we do not obtain all the carbon; the chromate, by losing oxygen, becomes less fusible, and the oxidation penetrates with difficulty to the centre of the larger grains of iron.

*Ibid.*

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*On the Preparation of Potassium and Sodium.* By M. WERNER. (*Journ. fur. prat. Ch.*)

It is extremely important for the successful preparation of these metals, to use an exact proportion of charcoal and alkaline carbonate. For the common quicksilver bottles there should be twenty ounces of cream of tartar, calcined in a close vessel and reduced to fine powder, to which add twenty drachms of charcoal also in powder, and twenty-four drachms of broken charcoal of the size of beans. Moisten the whole with a little water, and when the bottle containing the mixture has been placed horizontally in the furnace, push down the mass with an iron rod, so as to leave the neck perfectly free.

The neck of the bottle should not issue more than three inches beyond the furnace, and it must not be cooled that the metal may not condense in it. This cooling may be avoided by attaching to the neck a stopper of gypsum an inch long. Notwithstanding this precaution, the tube becomes obstructed three or four times in the course of the operation, but it is easily cleared by the iron rod.

The retort should be heated very slowly so that it may take an hour for the green vapours of the volatile metal to begin to shew themselves: then the receiver is to be attached, and a very uniform temperature to be kept up during the operation which commonly lasts three or four hours. From three and a half to four ounces of potassium, in large, pure lumps are produced, with carburet of potassium mixed with a little charcoal.

In the preparation of Sodium we must take a pound and a quarter of acetate of soda, carbonized (*charbonné*) mixed with a sufficient quantity of charcoal; and from this we get three and a half, four, and even four and a half, ounces of metal.

It is essential that the bottle be well luted with sand and clay, and the luting should be wrapped with a netting of iron wire. With these precautions the bottle may serve for two operations, care being taken to renew the lute.

*Annales des Mines tom xv*

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*On the Carbonization of Vegetables.* By M. CAGNIARD DE LA TOUR.

In heating, over the naked fire, closed glass tubes, into which I had previously introduced some poplar wood, either in pieces or in saw-dust, I remarked that at the moment when the wood arrived at the temperature of carbonization, namely, at about 360° C., it became flowing like bitumen,

although the wood had previously been dried ten or twelve hours in a stove heated to 100° C. From the report with which the tubes exploded at the moment when the fusion above mentioned takes place, there is reason to believe that the internal pressure, at that junction, exceeds eighty atmospheres. It is further remarkable that these tubes when they are broken after becoming entirely cold, in order to abstract the carbonized matter, which is then solid, still produce a strong explosion by the sudden expansion of the gases compressed within them.

The carbonized matter, when examined by a powerful lens, exhibits no trace of the woody texture. Heated to redness in the air, it inflames and leaves a charcoal but slightly combustible. Rubbed with alcohol it colours the liquid yellow.

Ibid.

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*New Chloride of Chrome.* By M. H. ROSE. (*L'Institut*, 1839.)

This modification of chromic chloride, insoluble in water, and of the greatest beauty, is obtained by heating strongly a mixture of the oxide of chrome and charcoal in a current of chlorine. There sublimes immediately a body of a scaly or crystalline, lamellar texture, of great splendour and of a magnificent colour.

This form of chloride of chrome, undergoes no change by exposure to air. Sulphuric acid does not decompose it; it may be heated when covered with this acid diluted, without change; the dilute acid may be evaporated, and the concentrated acid may be vaporized and distilled without decomposing the chloride. By heating it in the air it is transformed, like the other forms, into the oxide of chrome, with a disengagement of chlorine.

Ibid.

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*Preparing Sulphate of Iron so as to preserve it at a minimum of Oxidation.*  
By M. BERTHEMOT. (*I. de Phar.*)

Having dissolved and crystalized in water, sharpened with sulphuric acid, a portion of common sulphate of iron, exempt from copper and zinc, take 500 parts of it and dissolve it in 550 parts of distilled water: then add to the solution 8 parts of pure iron turnings, and after a few minutes filter it boiling hot, taking care to moisten the filter previously, that the liquid may flow through it more rapidly. Put the solution in a vessel containing 375 parts of alcohol at 33° to 36°, and 8 parts of sulphuric acid stirring it briskly with a glass rod as it is poured in. The sulphate of iron immediately precipitates in the form of a bluish white crystalline powder, and thus prepared it will remain in the air without the least alteration. It contains, besides, the same proportion of water of crystallization as that which is deposited from an aqueous solution. It is only after boiling it for some time in strong alcohol that it gives up a portion.

Ibid.

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*Presence of Arsenic in Tin.* By M. WÖHLER. (*Ann. de Phar. t. 29.*)

The greater number of the tins of commerce contain arsenic. I have found none, except the tin of Banca, and an English tin in lumps,\* which are exempt from it. The method of Marsh is perfectly adapted to show its presence. Dissolve from one half to one drachm of tin in concentrated

\* Most probably *Stream tin*.—TRANS.

hydrochloric acid, with heat, in a small gas bottle. Hydrogen gas escapes, which will not inflame immediately on account of the vapour of water and acid with which it is mixed. Collect it in a tube filled with water, and furnished with a stop cock, or otherwise connected with a pointed tube.

Inflame the gas, and let the burning jet play against a piece of cold porcelain,—the arsenic, if any be present, will be deposited, as is well known, in the form of a black shining coating. Ibid.

*Action of Ammoniacal Salts on Glass. By M. MARCHAND. (Ann. de Pog. t. 42.)*

Mixtures of hydrochlorate and nitrate of ammonia attack glass very strongly, especially when it contains lead.

When sulphate of ammonia is heated in a glass vessel, it begins to melt at  $140^{\circ}$ , and from that to  $280^{\circ}$  it undergoes no alteration; but at this temperature ammonia is disengaged, sulphate and sulphite of ammonia sublime, and we soon remark that the glass is strongly attacked; the interior surface becomes dull, from a combination of sulphuric acid with the potash. The glass often cracks and sulphate of potash issues through the crevices. Ibid.

*Hydrographic Paper.*

Paper is sold in Europe under the above title, on which, if one writes with water instead of ink, or even with the saliva of the mouth, the letters are black and perfectly legible.

This paper is prepared by steeping common white paper in a weak solution or infusion of gall nuts, and when dry rubbing over it finely powdered copperas (sulphate of iron.) It thus contains the elements necessary for the production of ink, and needs only the water necessary for their solution. The water traced by the pen effects this union and forms a black letter.

*Method of Discovering the Adulteration of Wax.*

The wax of commerce is too often mixed with various substances, and especially with potatoe flour. A simple method of detecting this sophistication is to melt a piece of the wax over a gentle fire, and then to dissolve it in a certain quantity of spirits of turpentine. The wax will entirely dissolve and the impurities be left behind, and by knowing the weight of the wax and ascertaining that of the sediment, the amount of the adulteration can easily be ascertained.

The colour given to wax does not, in general, injure its quality, but merely gratifies the eye of the purchaser.

*Deposition of Moisture on Metals. By M. BONSDORF.*

If we place, in an atmosphere saturated with humidity, a piece of polished zinc and a piece of tarnished lead in contact, when the temperature lowers the lead becomes covered with dew, and the zinc remains dry without oxydizing. It is thus with two different metals. The moisture settles on one only. If the effect be attributed to electricity we must conclude that the droplets are electrified positively. Ibid.



## Progress of Civil Engineering.

*Notes on the Philadelphia and Columbia Rail Road.* By W. H. WILSON, C. E.

The statistical information furnished by the following article, must prove acceptable, not only to every person who travels the road in question, now the great thoroughfare through the State of Pennsylvania, but to all who take a lively interest in the progress and nature of those great internal improvements whose commencement and rapid march will forever signalize the age in which we live.

We have been surprised, in traveling over the line of Canals and Rail Roads from Pittsburgh to Philadelphia, marked as it is at almost every stage by some of the grandest features of nature, and by the triumph of art over great natural obstacles, that no description of the route has been offered to the public, accompanied with a good map. Were a pamphlet, containing a descriptive and statistical account of the road, including a map, prepared by some one of the Engineers, and kept for sale in the passenger cars, and at the different Hotels on the route, as well as at other places, we could almost vouch for the ample reward which would accrue to the author, or publisher. The same may be said of the Reading, Baltimore, and other Rail Roads. We are surprised, that no publisher by profession, has taken up this subject, and engaged some one of the Engineers, on each of our great rail road and canal thoroughfares, to prepare suitable guide books, a procedure which we find has been effected in England, and doubtless with profit, in relation to the great rail road tracks. G.

WEST HAVERFORD, DEL. CO., PENN. }  
SEPTEMBER 12TH, 1839. }

From the American Railroad Journal.

Having been employed on the Columbia and Philadelphia railway during its construction, a great many notes relative to the character and cost of the different portions of the work, accumulated in my possession. Taking advantage of some leisure time this summer, (the first that has occurred since the completion of that work,) I have arranged these notes for my own satisfaction, and have added some statements relative to the subsequent operations upon the road. The object being merely to give a correct statistical account, I have abstained from giving expression to any opinions or speculations as to the character or merits of the work. In making comparisons of the performances on different railways, I have often felt the want of correct information as to the important features of the roads in question.

Under the impression that the same might be the case with others, I have thought the annexed account might not be uninteresting to your readers. Should you agree in this opinion it is at your service for publication.

Respectfully yours,

W. H. WILSON.

### *Columbia and Philadelphia Rail Road.*

This railway commences at the corner of Broad and Vine streets, in the City of Philadelphia, and terminates at the borough of Columbia on the Susquehanna river, the length being  $81\frac{6}{10}$  miles. It has been constructed and is still owned by the State of Pennsylvania.

In the year 1827, surveys of the route were made by direction of the

Legislature, and on the 24th of March, 1828, the construction of the railway was authorised as a State work. The location was commenced immediately after, and early in the year 1829 the grading and bridging of 40 miles of the road were put under contract; different portions of the work were successively contracted for, according to the yearly appropriations made for that purpose. On the 20th September, 1832, twenty miles of single track were opened for traveling; in April 1834, a single track was completed throughout, and in October of the same year, both tracks for the entire length of the road were open for public use. Much incidental work was, however, done after that time, the buildings for depots, workshops, &c. being in an unfinished state and some turn-outs, farm bridges, &c. not constructed.

Major John Wilson had charge of the operations on this line as Chief Engineer, from the commencement of the preliminary surveys, until a short time previous to his death in the spring of 1833, after which time the work was placed under the direction of Edward F. Gay, Esq. The following description will afford some general idea of the prominent features of this railway. From Broad street the line takes a northwesterly course passing near the Fairmount water works, and from thence runs nearly parallel to the Schuylkill river, which it crosses at the distance of about three miles from the city, the grades being undulating, to conform to the inclinations of the streets which are crossed. Immediately west of the river is an inclined plane of 2805 feet in length and 187 feet in height; this plane is straight and its inclination uniform. From the head of the inclined plane, the line is continued on the dividing ridge between waters flowing into the Delaware and Schuylkill, for about 19 miles, to a point near the intersection of the West Chester railway, where it attains an elevation of 543 feet above high tide; the grades on this portion of the road are varied and undulating, but generally ascending westward. The road now descends the northern slope of the South Valley hill into the Great Chester Valley, and after crossing Valley creek, comes to the East or Big Brandywine, at Downingtown; for nearly the whole distance, (about 11 miles,) the descent is at the rate of 29 feet per mile. The height of railway above high tide at Brandywine bridge is 250 feet. From East to West Brandywine, a distance of about 7 miles, the grades are generally ascending, the whole rise between those points being 121 feet. After crossing the West, or Little, Brandywine near Coatesville, the line ascends the Southern slope of the North Valley hill, until it reaches the summit of the Mine ridge at the Gap. According to the first location, an excavation of 37 feet was required at this point, but upon removing a few feet of the surface, the material below was found to be quicksand; after losing a great deal of time, and incurring heavy expense, in efforts to work down this cutting, it was deemed advisable to raise the grade so as to reduce the depth of excavation to 23 feet; in consequence of which, the grade now stands at 45 feet per mile, descending each way from the summit for three fourths of a mile, and then at forty feet per mile, for one-fourth of a mile, when it meets the original inclination of thirty feet per mile. The Gap summit is 553 feet above high tide at Philadelphia. From this point the road descends, and after crossing Pequea creek, Mill creek, and Big Conestoga, enters the city of Lancaster; leaving which, it is conducted across Little Conestoga, towards the head of the inclined plane at Columbia. This plane is 1800 feet in length and 90 feet in height; it is straight and its inclination uniform. From the foot of the plane, the road continues along the margin of the river

Susquehanna, in front of the town, to the outlet lock and basin of the Pennsylvania Canal. It is graded along the edge of the basin, sufficiently low for the convenient transfer of articles from one mode of conveyance to the other.

The passage of a law to authorize the construction of this railway by the Commonwealth, met with serious opposition, and even after the work had been commenced, it was for some time a matter of doubt whether operations would not be suspended. Under these circumstances, it was the earnest desire of the friends of the road, that as much economy should be used in the construction, as was consistent with a due regard to the utility of the work, when completed. Previous to commencing the location, it became necessary for the Engineer to determine upon its governing principles, and in order to establish these, recourse was had to the experience gained upon works of a similar kind already in operation. It must be recollected that this was in the year 1828, previous to the opening of the Liverpool and Manchester railway, when there were but few railways of any extent in use, and those of very imperfect construction. It was also prior to the successful use of the locomotive engines; it is true that these machines were then operating upon some of the English railroads, but their use was attended with so many objections, that very few were sanguine enough to anticipate their general adoption. After the most mature consideration of the subject, the maximum grade of the Columbia and Philadelphia railroad, was fixed at 30 feet per mile, and its minimum radius of curvature, at 631 feet, these being the limits to which it was thought prudent to go, with an eye to economy of construction on one hand, and the useful effect of the road on the other. The principles here laid down have been adhered to with one exception, which is the increase of grade in surmounting the Mine ridge at the Gap; the distance however for which the grade has been raised is so short, that the difference is scarcely felt by trains passing over the road. It may be proper to observe here, that in references made to this railway by companies prosecuting rival works, or by others interested in representing it in the most unfavourable light, the minimum radius of curvature is stated at 300 feet; there is a curve of this radius 7 chains in length, at the termination of the road, but it is in the streets of Philadelphia, beyond the point at which the locomotive engines are stopped and the trains separated, and ought no more to be taken into view, when referring to the road, than ought the numerous abrupt curves through the Northern Liberties, to be considered as parts of the Trenton Railway. The inclined planes on this road being a source of expense and delay to the transportation, every possible effort has been made to avoid them. A new route of six miles in length has been located, and is now nearly completed, by which the plane at Columbia will be dispensed with; the distance is about the same as the part of the old line to be abandoned, and the grade 35 feet per mile. Several routes have been surveyed for the purpose of avoiding the inclined plane near Philadelphia, but as yet no alteration has been adopted by the State. Two roads have been commenced by chartered companies for this purpose. The West Philadelphia railway is about 8 miles in length, its maximum grade 57 feet per mile, and its average grade  $43\frac{3}{10}$  feet per mile; the grading of this road is principally done, but the work is now suspended for want of funds. The other route is by the Valley and Norristown railroads; the distance by the Valley road is  $20\frac{1}{4}$  miles, and then by the Norristown road  $13\frac{1}{2}$  miles, making a total of  $33\frac{3}{4}$  miles or  $2\frac{1}{2}$  miles more than the portion of the State road to be avoided; the maximum grade of the



Valley road is  $35\frac{7}{10}$  feet per mile, and of the Norristown  $37\frac{4}{10}$  feet per mile; the latter road is graded for two tracks, and has one track now in use; on the Valley road the grading is partly done. On no other route yet surveyed for avoiding this plane is the grade less than 40 feet per mile.

The following is a summary of the straight lines and curves on the Columbia and Philadelphia railway.

|                                    | Miles. | Chains. | Links. |
|------------------------------------|--------|---------|--------|
| Straight line, . . . . .           | 56     | 62      | 54     |
| Curve of 3782 feet radius, . . . . |        | 75      | 25     |
| “ 1981 “ . . . . .                 | 5      | 24      | 16     |
| “ 1513 “ . . . . .                 |        | 57      | 00     |
| “ 1260 “ . . . . .                 | 6      | 16      | 73     |
| “ 968 “ . . . . .                  |        | 8       | 42     |
| “ 946 “ . . . . .                  | 6      | 29      | 04     |
| “ 841 “ . . . . .                  |        | 0       | 67     |
| “ 757 “ . . . . .                  | 3      | 61      | 29     |
| “ 631 “ . . . . .                  | 1      | 25      | 95     |

*Grading.*—The width of road is 25 feet in the excavations, and by the original design it varied on the embankments from 22 to 25 feet according to the supply of material, but at this time the top width of embankments generally exceeds 25 feet. The deepest cuttings on the line are between 30 and 40 feet, and the highest embankment is 80 feet.

*Inclined planes.*—The inclined plane at Schuylkill river is 2805 feet in length and 187 feet in height; at the head of the plane is a building composed of two wings built of stone, connected by a wooden structure over the roadway. Each wing is calculated to hold a stationary steam engine of 60 horse power; only one, however, has been put up. The rope is an endless one, of nine inches circumference when new, and cost about \$2,800. The first rope used was  $6\frac{3}{4}$  inches in circumference, cost \$2,100, weighed  $5\frac{1}{2}$  tons, and lasted about one year. The inclined plane at Columbia is 1800 feet in length, and 90 feet in height. The engine house at the head of plane is built of brick, and designed to accommodate two steam engines of 40 horse power each, one of which is put up. On both of these planes, double tracks are laid, and cars are passed up and down at the same time.

*Culverts.*—The culverts are all built of stone, and the masonry is either hammer dressed, or rubble work; they are 75 in number, with spans varying from 4 to 25 feet, and contain 31,161 perches of masonry.

*Bridges.*—The number of railway bridges, or viaducts, is 22; they are constructed with stone abutments and piers, surmounted by wooden structures, and contain 61,425 perches of masonry, and 7,212 lineal feet of wooden platform. Two of these bridges, supported on small stone piers and wooden trestles, have lately been replaced by embankments. There are 33 bridges across the railway for public and private roads. The following are the most important viaducts.

*Schuylkill viaduct.*—The superstructure is composed of wood, with four distinct trusses, formed of arch pieces, king posts, and braces, being a modification of Burr's plan. The whole width from out to out, is 49 feet 8 inches, which admits of three separate passages, two of  $18\frac{1}{2}$  feet each, in the clear, and one of four feet; the latter is intended for foot passengers, one of the former for two railway tracks, and the other for common carriages. The spans are seven in number, and their lengths in clear, between the piers are as follows; two of 122 feet each, three of 135 feet each, and two of

137 feet each. The eastern abutment and four piers are founded upon solid rock; the remaining abutment and piers, upon hard gravel. The masonry is coursed and hammer dressed. Five of the piers were built in the river and required coffer dams; one of which stood in 26 feet depth of water. The whole length of wooden platform is 1,045 feet, and the number of perches of masonry 19,100. The height of the bridge floor above the usual water line, is 38 feet. The total cost including painting inside and outside, was \$133,946.57.

*Valley Creek viaduct* consists of four spans, each 130 feet in clear between the piers. The piers are built of rubble masonry, and vary from 56 to 59 feet in height. The original structure was on Burr's plan, having two trusses, with a clear width of  $18\frac{1}{2}$  feet, and cost, including stone work, \$22,254.21. The wood work was destroyed recently by fire, and replaced by a lattice bridge (lowered so as to admit of the railway being carried over the top,) at a cost of \$17,218.13.

*East Brandywine viaduct* has four spans, two of 88 feet 8 inches each, and two of 121 feet 7 inches in the clear. The superstructure is on Burr's plan with a clear width of  $18\frac{1}{2}$  feet. The whole length of platform is 477 feet, and the height of floor above water in the creek, 30 feet. Cost \$17,523.20.

*West Brandywine viaduct* has a wooden superstructure, resting upon abutments and piers of coursed masonry with rustic faces, commonly denominated rock work. The length of the bridge platform is 835 feet divided into six spans; its greatest height above the water is 72 feet. The whole cost of stone and wood work is \$57,916.00. The plan is similar to that of the bridge over East Brandywine, except that the superstructure is lowered for the railway to pass over its top. This and the new bridge at Valley Creek, are the only two of the principal structures, on this line, in which the usual form of roof is dispensed with.

*Pequea viaduct* is a single span of 130 feet, on Burr's plan, and cost \$8,735.50.

*Mill Creek viaduct* is built on Burr's plan; the whole length of wooden platform is 550 feet, and its greatest elevation from the water 40 feet. Cost \$9,273.18.

*Big Conestoga viaduct* is 1,412 feet in length, and is elevated 60 feet above the water. The piers are built of rubble masonry, and the superstructure is lattice work on Town's plan. Whole cost \$31,503.57. The longest span of this bridge is 120 feet.

*Little Conestoga viaduct.*—The piers are built of rubble masonry and the wood work on Burr's plan. The flooring is 804 feet in length, and is elevated 47 feet above the water of the creek. Cost \$15,359.00.

*Railway superstructure.*—The length of road being, as before stated,  $81\frac{6}{10}$  miles, there are  $163\frac{2}{10}$  miles of single track; of which six miles are laid with granite sills plated with flat iron bars, 18 miles with wooden string pieces plated in a similar manner, two miles with stone blocks and edge rails, having stone sills extending across the track at every 15 feet, and  $137\frac{2}{10}$  miles with stone block and edge rails, (having wooden sills extending across the track at intervals,) except on some of the embankments, where the edge rail is secured, to cross sills of wood, supported by mud sills.

*Granite Track.*—The trenches are dug in the direction of the road, two feet in width, and 22 inches in depth, measuring from the level of top of sill. Broken stone is then placed and compacted in layers of 3 inches each.

Upon this are laid granite sills varying in length from 3 to 12 feet, and one foot in depth and width. Holes are drilled into the stone (to correspond with the holes in the bars, and to suit the width and position of the track) three and a half inches in depth, and  $\frac{5}{8}$  of an inch in diameter. Into these holes, plugs of locust wood are driven, to receive the spikes which secure the iron bars, which are 15 feet in length,  $2\frac{1}{4}$  inches in width, and  $\frac{5}{8}$  of an inch in thickness. The inner edge of the sills, is chamfered off for a width of two inches, and the outside is backed up with broken stone. Horse power being used on the road when this track was laid, a horse path was formed of broken stone or gravel 6 inches in depth. The average cost for one mile of this track, including the trimming and dressing off half the width of roadway was \$10,179.20.

*Wooden Track.*—The trenches are dug across the road, four feet apart, eight feet in length, one foot in width, and 16 inches in depth (making 24 inches to top of wooden rail.) Into these, broken stone is rammed in layers, upon which are laid sills of chestnut or white oak, seven and a half feet long and seven inches square. The sills are notched to receive a yellow pine string piece 6 inches square, which is secured in its place by wooden wedges. Flat iron bars are then spiked on similar to those used on the granite track; the horse path is also similar. This track cost \$5,604.48 per mile.

The two kinds of superstructure just described, have been in use on this road about seven years, but during the last year, they have been traveled over only by a few cars drawn by horses, being so much out of order as to be unsafe for locomotive engines. The wooden sills and string pieces have become decayed, and in both cases the iron bars are constantly working loose. In many places these bars have been broken, or split, by the heavy weights passing over them, particularly on the stone track. It is intended to renew this portion of the road with edge rails; a short distance has already been done.

*Edge rails on stone blocks and sills.*—The trenches are dug in the direction of the road, 28 inches wide, and 24 inches deep, (from top of block;) at every 15 feet these are connected by a cross trench 16 inches wide. Broken stone to the depth of 12 inches, is well rammed in layers; the blocks and sills are then settled in their places by heavy rammers, and backed up to their tops with broken stone. The blocks are of granite, or other hard stone, 20 inches long, 16 inches wide, and 12 inches deep; the sills are of the same material, six and a half feet in length, and one foot square, placed across the track at every 15 feet; the blocks are so arranged as to give a support to the rails at every three feet. Cast iron chairs weighing 15 lbs., are secured to the blocks and sills, by bolts driven into cedar plugs previously inserted into the stone; there are two bolts to a chair, weighing 10 ounces each; between the stone and chair, a piece of tarred canvass is inserted. The rails are of rolled iron, 15 feet long, three and a half inches deep, parallel at top and bottom, and weigh  $41\frac{1}{4}$  lbs. per lineal yard. The rail is secured in the chair by two wrought iron wedges, one on each side, weighing 10 oz. The horse path for this track is formed of broken stone and gravel nine inches deep. Average cost of one mile \$12,568.85.

Several miles of track were laid in a similar manner to the above, omitting the stone sill, and substituting in its place two blocks, at a cost of \$10,927.88 per mile. This kind of track was found so liable to spread, particularly in the spring of the year, when the ground was soft, that wooden sills have since been put in at intervals, connecting the two rails of the track.



*Edge rails on stone blocks and locust sills.*—This kind of track is similar to the edge rail track already described, with the following exceptions; instead of stone sills, locust are used, placed 15 feet apart on the straight lines, and nine feet apart on the curves; to suit which, some bars were rolled in lengths of 18 feet; the stone horse path is dispensed with, the tops of the blocks and sills being level with the graded surface of road. The average cost of one mile on this plan is \$13,240.92; the excess over the cost of the track where stone sills were used, is owing to a rise in the cost of iron, from \$41 to \$50 per ton (delivered in Philadelphia.) On newly formed embankments the following plan was adopted; longitudinal trenches were dug, 22 inches wide, and 22 inches deep; broken stone to the depth of 6 inches, being rammed in, string pieces of white oak or chesnut were laid, 12 inches deep by 10 inches wide; these being notched to the depth of 2 inches, cross sills of the same material, 6 by 8 inches, were secured to them at every 3 feet by pins or wedges. On these sills the iron chairs, rails, etc., were placed. The trenches were connected at intervals, by cross trenches, running out to the edge of the embankment, for the purpose of carrying off any water which might collect. This description of track cost \$12,905.35 per mile.

This road having been designed and constructed with a view to the use of horse power, a system of turn-outs and side tracks was adopted with particular reference to that kind of traveling. Turn-outs were placed at intervals from one track to the other, and side tracks were constructed adjacent to each of the main tracks, at the distance of one mile and a half apart, for the whole length of the road; these side tracks measured as follows; 160 feet in length parallel to the main track, and 70 feet at each end, curved to the intersection with outside rail of main track. They afforded a space of about 200 feet in length for cars, and as the cars always entered in the same direction after both tracks were completed, only one movable switch was used. The castings were according to J. Elgar's plan, and were made under his direction. Upon the introduction of steam power upon the road, the numerous castings were found very objectionable, and useless; nearly all of them were consequently taken up, and most of the side tracks were also removed. Wherever it has since been found necessary for the accommodation of business to have turn-outs or crossings, new castings have been made use of, better adapted to the present mode of traveling.

The branches connected with this railway which have been completed for use are, the West Chester railway 10 miles in length, intersecting about 22 miles from Philadelphia, and the Harrisburg railway 40 miles in length, connecting at Lancaster, 12 miles from the western extremity. On the former of these roads, horse power is used; on the latter, steam power;—both belong to chartered companies. The following table exhibits the cost of the Columbia and Philadelphia railway as nearly as can be ascertained. From the commencement of the work to the time of its being opened for public use, the gross amount of the appropriations for purposes of construction could easily be obtained; but since that period various sums have been appropriated yearly to this road, some of which properly belong to the item of construction, while others have been applied to objects not connected therewith.

All the documents relating to this subject have been carefully examined and the result is believed to be as correct as can possibly be obtained.

*Total cost of Columbia and Philadelphia Railway.*

|                                                  |   |   |   |   |   |              |
|--------------------------------------------------|---|---|---|---|---|--------------|
| Grading,                                         | - | - | - | - | - | \$649,158 69 |
| Culverts,                                        | - | - | - | - | - | 74,113 94    |
| Railway bridges or viaducts,                     | - | - | - | - | - | 327,695 80   |
| Road and farm bridges,                           | - | - | - | - | - | 42,055 00    |
| Fencing,                                         | - | - | - | - | - | 65,410 86    |
| Railway superstructure,                          | - | - | - | - | - | 2,181,156 25 |
| Buildings and machinery,                         | - | - | - | - | - | 111,787 12   |
| Engineering and superintendence,                 | - | - | - | - | - | 133,934 31   |
| Damages,                                         | - | - | - | - | - | 54,833 29    |
| Repairs,                                         | - | - | - | - | - | 42,451 76    |
| Incidental,                                      | - | - | - | - | - | 11,980 18    |
| Alteration to accommodate the city of Lancaster, | - | - | - | - | - | 60,000 00    |

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\$3,754,577 20

Cost when the road was open for use in 1834; after which the following additional expenditures were made.

|                                            |   |   |   |   |   |            |
|--------------------------------------------|---|---|---|---|---|------------|
| Locomotive engines,                        | - | - | - | - | - | 327,203 41 |
| Additional buildings, turn-outs, &c.,      | - | - | - | - | - | 37,511 16  |
| Retained per centage on old contracts,     | - | - | - | - | - | 5,134 08   |
| Engineering,                               | - | - | - | - | - | 4,741 25   |
| New ropes at inclined planes,              | - | - | - | - | - | 11,584 34  |
| Embankment at Maul's bridge,               | - | - | - | - | - | 1,796 34   |
| Renewal of wooden track,                   | - | - | - | - | - | 18,907 48  |
| Rebuilding Valley creek bridge,            | - | - | - | - | - | 17,218 13  |
| New road to avoid Columbia inclined plane, | - | - | - | - | - | 118,123 53 |

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\$4,296,796 92

The following particulars in relation to the working of the Columbia and Philadelphia railway, are compiled from the annual reports of the officers of the road, up to October 31st, 1838, the date of the last report.

|                                               | Road expenses. | Motive power expenses. | Road tolls. | Motive power tolls. | Total expenses. | Total tolls. |
|-----------------------------------------------|----------------|------------------------|-------------|---------------------|-----------------|--------------|
|                                               | \$ cts.        | \$ cts.                | \$ cts.     | \$ cts.             | \$ cts.         | \$ cts.      |
| From commencement of travel, to Oct. 31, '35. | 41,973 13      | 55,246 27              | 185,560 67  | 43,790 55           | 97,219 40       | 229,351 22   |
| From Oct. 31, 1835 to do. '36.                | 75,311 32      | 184,878 84             | 173,837 12  | 90,969 12           | 260,190 16      | 264,806 24   |
| From Oct. 31, 1836 to do. '37.                | 59,024 95      | 114,859 76             | 211,324 16  | 137,338 67          | 173,884 71      | 348,662 83   |
| From Oct. 31, 1837 to do. '38.                | 44,033 23      | 133,820 90             | 233,588 75  | 164,052 74          | 177,854 13      | 397,641 49   |
|                                               | 220,343 63     | 488,805 77             | 804,310 70  | 436,151 08          | 709,148 40      | 1240,461 78  |

All the cars used on this road belong to individuals or companies, but the motive power is furnished by the State, except in the case of the West Chester cars and some few others, which are drawn by horses. Every thing connected with the management of the motive power is entrusted to an officer styled "Superintendent of motive power;" the repairs of the road are attended to by a Supervisor; these officers are independent of each

other, appoint all persons employed under them, and report annually to the Board of Canal Commissioners on the state of their respective departments. There are five offices for the collection of tolls, the incumbents of which are appointed by the Board of Canal Commissioners. Separate accounts are kept by the collectors, of the tolls received for the use of the road, and for motive power; the latter constitute a fund, out of which all expenses in that department are paid; for the repairs of the road, yearly appropriations are made by the Legislature.

The rates of toll for the use of the road vary from six mills to four cents per ton (of 2000 pounds) per mile; there are 12 different rates, the average of which would be two cents per ton per mile. The lowest rates are for coal, stone, iron ore, vegetables, lime, manure and timber; and the highest are for dry goods, drugs, medicines, steel and furs. On the United States Mail, the toll is one mill per mile, for every ten pounds; on every passenger one cent per mile. In addition to these rates, a toll is levied, of one cent per mile on each burthen car, two cents per mile on each baggage car, and on every passenger car one cent per mile for each pair of wheels. The motive power toll is, for each car having four wheels, one cent per mile, for each additional pair of wheels five mills, for each passenger, one cent per mile, and for all other kinds of loading, 12 mills per ton (of 2000 pounds.) The owners of cars now charge \$3,25 for every passenger, and \$7,50 for every ton of merchandize conveyed the whole length of the road, they paying all tolls: which is at the rate of four cents per mile for a passenger, and  $9\frac{14}{100}$  cents per mile for a ton of goods. Taking the length of the road at 82 miles, the average number of passengers to an eight-wheel car at 30, and the load of a four wheel burthen car at three tons, we have the following results:

|                                  |   |   |   |                   |
|----------------------------------|---|---|---|-------------------|
| Road toll on an eight-wheel car, | - | - | - | 4 cents per mile. |
| “ “ 30 passengers,               | - | - | - | 30 “ “            |
| Motive power toll on car,        | - | - | - | 2 “ “             |
| “ “ 30 passengers,               | - | - | - | 30 “ “            |

Total toll for 30 passengers, - 66 “ “  
or  $2\frac{1}{10}$  cents per mile for each passenger, leaving  $1\frac{8}{10}$  cents per mile to the owners of the car for every passenger.

|                                        |   |   |   |                     |
|----------------------------------------|---|---|---|---------------------|
| Road toll on a four wheel burthen car, | - | - | - | 1 cent per mile.    |
| “ “ three tons of dry goods,           | - | - | - | 12 “ “              |
| Motive power toll on car,              | - | - | - | 1 “ “               |
| “ “ three tons of goods,               | - | - | - | $3\frac{6}{10}$ “ “ |

Total toll on three tons of dry goods,  $17\frac{6}{10}$   
or 5 86-100 cents per ton per mile, leaving 3 28-100 cents per ton per mile to the owner of the car.

In making comparisons between the working of this and other railways, the error has generally been committed, of taking the motive power expenses (given in the reports of the State officers) as the whole cost of transportation; it must be recollected, that the State merely furnishes the moving power; the owners of cars have to provide their own workshops, and depots for receiving and depositing good; they are also obliged to send agents with their cars and have to take the risk of all accidents. The duty of the State agents who accompany each train, is to regulate the motions



of the train, and to see that proper returns are made to the collectors, of the passengers and freight conveyed.

*Details of Motive Power expenses for the year ending October 31st, 1838.*

|                                             |   |   |   |   |              |
|---------------------------------------------|---|---|---|---|--------------|
| Expended at workshops,                      | - | - | - | - | \$14,102 05  |
| “ “ inclined planes,                        | - | - | - | - | 16,942 90    |
| Superintendent, clerk, and car agents,      | - | - | - | - | 8,022 00     |
| Car inspectors,                             | - | - | - | - | 1,196 00     |
| Conductor of State cars,                    | - | - | - | - | 407 50       |
| Engineers of locomotives,                   | - | - | - | - | 10,786 00    |
| Firemen,                                    | - | - | - | - | 6,662 87½    |
| Watermen,                                   | - | - | - | - | 6,825 00     |
| Woodmen,                                    | - | - | - | - | 8,212 22     |
| Wood,                                       | - | - | - | - | 27,889 33¾   |
| Coal,                                       | - | - | - | - | 10,732 67½   |
| Materials for engines,                      | - | - | - | - | 20,720 91¼   |
| Oil,                                        | - | - | - | - | 6,568 85     |
| Miscellaneous,                              | - | - | - | - | 852 62       |
|                                             |   |   |   |   | <hr/>        |
|                                             |   |   |   |   | \$139,920 94 |
| Add amount of debts contracted,             | - | - | - | - | 5,600 00     |
|                                             |   |   |   |   | <hr/>        |
|                                             |   |   |   |   | 145,520 94   |
| Deduct stock on hand, fuel, iron, oil, &c., | - | - | - | - | 11,700 00    |
|                                             |   |   |   |   | <hr/>        |
|                                             |   |   |   |   | \$133,820 84 |

During the same year, the number of passengers conveyed, was 103,336 way and through, equal to 75,612 through; the number of tons of freight transported was 87,180, and the whole number of miles traveled was 260,-400.

*List of persons employed in Motive Power Department.*

|                                                  |   |   |   |                 |
|--------------------------------------------------|---|---|---|-----------------|
| Superintendent of motive power, at               | - | - | - | \$4 00 per day. |
| Clerk,                                           | - | - | - | 2 00 “          |
| 2 car inspectors, each,                          | - | - | - | 2 00 “          |
| Manager between Philadelphia and inclined plane, | - | - | - | 2 50 “          |
| 4 agents for passenger trains each,              | - | - | - | 2 00 “          |
| 5 “ “ burthen, “ “                               | - | - | - | 1 50 “          |
| Conductor of State cars,                         | - | - | - | 1 25 “          |
| Master Machinist,                                | - | - | - | 4 00 “          |
| 2 Foremen of workshops, each,                    | - | - | - | 2 00 “          |
| 18 Machinists, pay varying from 1 00 to          | - | - | - | 2 00 “          |
| 9 Smiths, “ “ 1 50 to                            | - | - | - | 1 92 “          |
| 9 Assistants, each,                              | - | - | - | 1 25 “          |
| Engineer of stationary engine at workshop,       | - | - | - | 1 16 “          |
| Watchman,                                        | - | - | - | 1 16 “          |
| 2 Managers, at inclined planes, each,            | - | - | - | 2 50 “          |
| 2 Engineers “ “ “                                | - | - | - | 2 00 “          |
| 2 Firemen “ “ “                                  | - | - | - | 1 25 “          |
| 2 Riggers “ “ “                                  | - | - | - | 1 50 “          |
| 11 Signal men, and assistants, “                 | - | - | - | 1 25 “          |
| 26 Engineers of locomotives, “                   | - | - | - | 2 00 “          |

|                                  |   |   |   |      |   |
|----------------------------------|---|---|---|------|---|
| 33 Firemen of locomotives, each, | - | - | - | 1 25 | " |
| 19 Watermen,                     | - | " | - | 1 00 | " |
| 33 Woodmen,                      | - | - | " | 1 00 | " |

The superintendent in his report dated October, 1837, states as follows: "The heavy locomotives now used for the transportation of freight are capable of drawing thirty-five cars, each with a load of three tons, or one hundred and five tons, exclusive of the cars, engine, and tender. If their weight be added, the whole will be one hundred and ninety tons." "The average number of cars to each engine, actually hauled during the season, falls far short of the number just given; this is owing to the irregularity and decrease of business which prevailed, and to the rule, which for the accommodation of the trade was adopted, of starting a train whenever one of sufficient size to justify the expense had accumulated, without delaying, and increasing the expense of the transporters by waiting for a full one.

The number of locomotive engines on the road at the date of the last report was thirty-six, of which, twenty-seven were in good order. The daily duty of the engines is to run from the head of one inclined plane to the head of the other, a distance of seventy-seven miles; between the foot of the Schuylkill plane and Philadelphia, a distance of three miles, two engines are generally kept employed in taking the trains to and fro: from the Columbia plane to the canal basin, horse power is used, the distance being only one mile.

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*On Steam Engines, principally with reference to their Consumption of Steam and Fuel. By J. PARKES.*

This is the second and concluding communication on this subject. In the former, the generation of steam was more particularly considered (see *Athenæum* No. 601); in the present, its application when generated. These are distinct questions, as it is the economy of steam which constitutes the dynamic perfection of a steam engine, whereas it is the economy of heat in supplying that steam which constitutes the perfection of the boiler as an evaporative vessel. These economic properties are totally independent of each other; they may co-exist in a maximum degree, or in very different degrees, and the degree of perfection which any particular class of engines, or which the particular engines of any class, possess, is known from the weight of fuel burnt, of water evaporated, and the mechanical effect realized. As long as engines were constructed with but few varieties, or identical in their forms, the performance of one was a sufficient indication of the performances of all; but new forms of engines and new modes of practice being now introduced, a comparison of the performance on the several systems is a matter of deep practical and scientific interest. With the view of effecting this object, the author has collected all the authentic facts within his reach, and reduced them to common standards of comparison.

The effective power of steam engines may be ascertained either from the resistance overcome, or from the load upon the piston by means of the indicator: the former method being applicable to pumping, the latter to rotative engines. But the effective power of steam in pumping engines, as thus ascertained, is far below the real effective power of the steam, and no exact comparison can be made by these means between the effective power of the steam in the two classes of engines. The useful effect is not synonymous with a true measure of effective power, since the duty is the true use-

ful effect in a Cornish engine. The indicator when applied to the Cornish engines enables us to ascertain the absolute, but not the effective, power, so as to compare it with that of the rotative engine, since the friction of the engine and the load cannot be separately determined. The absolute power of the steam may also be ascertained from the relative knowledge of the elastic force of steam corresponding with the ratio which the volumes of water bear to each other. This theoretical estimate requires, however, several corrections; among which the steam condensed by contact with colder surfaces, the steam consumed in filling useless places, and that lost by priming, must be particularly noted. The relative performance of pumping engines is well expressed by the term "duty," that is, the number of pounds raised one foot by a given quantity of fuel; and of rotative engines by the term "horse power," that is, the number of pounds raised one foot in a minute, divided by 33,000 lb., the standard measure of a horse. The performance of the rotative engine may also be estimated by duty, and of pumping engines by horse power. The results of these computations for several engines are tabulated in this communication. The sum of the latent and sensible heat being constant for steam of all elasticities, the expenditure of both power and heat is truly measured by the weight of water consumed as steam; this measure is free from all uncertainty, and independent of all theory; the weight of water as steam equivalent to the production of a horse power in each engine, and the duty effected by one pound of steam, will denote the positive and relative efficiency of the steam and the heat. These indices of efficiency being referred to some standard, we learn, from the preceding data, the precise value of each engine in its use of steam and fuel; of its boiling apparatus, as a generator of steam; of the comparative efficiency of the steam and coal, or economy of power and fuel. The results which may thus be obtained are also exhibited in tables, accompanying the communication. The power resulting from the expenditure of equal weights of water, as steam, being known, the boiler may be connected with the engines, and the relative extent of heating surface employed to furnish their power, shown. It will thus appear that equal measures of surface are quite inadequate to supply equal power, with equal economy, to different classes of engines. These results are tabulated in great detail, and it appears that the Cornish engineers now employ nearly eight times as much boiler surface for equal nominal power as that given by Watt's practice. But taking into account the fuel burnt per horse power per hour in the two cases—the Cornish engine consuming  $2\frac{1}{2}$  lb. per horse power per hour, and Watt's engine  $8\frac{1}{2}$ —the true relation of the boilers is as 19 to 1. Many other relations of a similar striking character may be deduced from these tables. The detailed results of the experiments by Smeaton in 1772, on his improved Newcomen engine at Long Benton—by Watt, in 1786, on his rotative condensing engine, at the Albion Mills—are recorded in these tables; and it appears, that the economy of the latter as regards steam and fuel, was double that of the former, and approached very nearly to perfection in the use of power obtainable on that principle. The next great advance in the economy of fuel and power, is that made by the Cornish engineers, whose performances, both with pumping and rotative expansive engines, far exceed any attained with the common unexpansive condensing engines. The superiority of two of these engines in 1835, doing a duty of 80 millions, exceeds the engines of Watt and Newcomen by  $2\frac{1}{2}$  and 5 times in economy of power, and by  $3\frac{1}{2}$  and 7 times in economy of fuel.

The obtaining a standard measure of duty is of great importance; a heaped



measure as a bushel of coals is highly objectionable, as the weight of such measure will vary from 84 to 112 lb. In the Cornish reports, the bushel is fixed at 94 lb. weight as the standard of comparison, but some portion of a ton or one pound would be a better standard. Other combustibles, however, as coke, peat, &c., may be used partially, or to the exclusion of coal, and under these circumstances some other standard of comparison is necessary; and with this view the author suggests a pound of water in the form of steam as the best standard of duty. The work done by a given quantity of water as steam is a sure index of the quality of the steam engine; it is a measure unaffected by variable calorific agents, and, so long as engines continue to be worked by steam, so long will the performance of different engines be accurately gauged by their respective expenditures of water as steam. The accuracy of this measure depends on the physical fact of the constancy of the latent and sensible heat in steam of all temperatures. The author has recorded twenty-eight experiments, made on twenty-eight different days, on vaporization from the boiling point to 60 lb. pressure above the atmosphere, which present a remarkable confirmation of the above law, and show that the relative efficiency of steam in engines is due to the manner of using it, and not to any change in its chemical constitution at different pressures. The manner of conducting these experiments, and the precautions taken to insure accurate results, are detailed with great minuteness.

The author next proceeds to treat of the Locomotive Engine, and to discuss, compare and tabulate the facts relating to this engine in the same manner as he has done those of the stationary class. The qualities of the boiler of the locomotive as an evaporative vessel had been discussed in the first communication. The locomotive differs from the fixed non-condensing engine only in the use of the blast, and the same method of measuring the effects of the steam are applicable to both. Experimenters on the locomotive have generally attempted to determine the amount of resistance opposed to its progress in preference to ascertaining the power expended in overcoming the resistance. The exact solution of either of these questions would furnish all that is wanted; but the ascertaining the total resistance by an analysis of its several constituents is attended with great difficulties, as the forces to which they are to be referred are so exceedingly numerous and variable, that the assigning the exact value to each at any one velocity has hitherto eluded the talents of those who have pursued this method. M. de Pambour was the first analyst whose labours will require attention. The results given by this author in his practical treatise on locomotive engines on railways were compared by Mr. Parkes with the results which he had obtained when experimenting on an engine of precisely a similar character, and discrepancies presented themselves which appeared totally irreconcilable. These and other circumstances led the author to consider, whether the resistance to traction would properly be deduced from the laws of gravitation, or whether any certain results would be derived as to the amount of resistance on a level from observations on engines and trains moving down inclined planes. The great object seemed to be to discover some criterion of the mechanical effect produced by a locomotive at all velocities, which would apply as practically and as distinctly to a locomotive as duty to a pumping engine, or horse power to a rotative engine. If this were possible, it seems of far less importance to distinguish the precise value of each particular unit of resistance, than to determine the relative sum of resistance and the relative expenditure of power at all velocities and under all circumstances. Now the term duty may be applied in the

strictest sense of the term to the work done by the locomotive engine; for whether the engine drag a load whose resistance is 8 lb. per ton, or whether a weight of 8 lb. for each ton of matter moved descending over a pulley and attached to the load, be considered as the moving force, the result is the same. If, then, the tractive force, or resistance, per ton of matter in motion, which is the real load on the engine, be ascertained, the whole effect is found by multiplying this sum by the space passed over in feet; and the consumption of water as steam and of coke, being known, we have all the elements requisite for determining the duty performed by the steam or coke. The pressure against the pistons may be deduced from the sum of the resistances first calculated on the assumed resistance overcome at the velocity of the engine in each experiment; and the pressure on the pistons may also be deduced from the ratio of the volumes of the steam and water consumed. The results which may be obtained on these principles are tabulated, from the experiments of M. de Pambour, Robert Stephenson, and Dr. Lardner. In another table, the author has recorded the reduction of each of these experiments to terms of horses' power, and has exhibited under that denomination the absolute power resulting from the steam used—that is required to overcome the assigned resistance—their differences—and the power which balances the gross and useful duty. The construction of these most elaborate tables is described in great detail, and the consequences which follow from the tests thus obtained are fully stated; and the author comes to the conclusion, that results inconsistent with the capabilities of the locomotive are perceptible in almost every one of the experiments. A condensing engine placed on wheels, with water of condensation transported for its supply, and made to drag a train along a railway, would require the same expenditure of water as steam, to produce a given effect, as if fixed; a non-condensing engine also is one and the same machine, whether fixed or locomotive, excepting that the latter must consume more power than the former, to do equal work, at like pressure, by the amount of the additional resistance arising from the contraction of its eduction pipes, in order to produce a fierce blast of steam through the chimney. From these and other causes the fixed non-condensing engine must be the more economical of the two; but if the results derived from M. de Pambour's data be correct, we must acknowledge the fixed non-condensing engine, with its simple atmospheric resistance, to be far inferior in economy of steam to the locomotive, with its plus atmospheric resistance. The experiments by Dr. Lardner were made for the purpose of determining the resistance opposed to progressive motion on railways. They consisted in dismissing trains at various speeds from the summit of inclined planes, and in observing their velocity when it became uniform, the resistance at such velocity being equal to the accelerating force of gravity down the inclined plane. The results of these are tabulated in the same manner as the preceding, and the most singular discrepancies present themselves. For instance, it would appear that in one particular case a duty of double the amount of that effected by the condensing engine was performed by an equal expenditure of power; that compared with a fixed non-condensing engine at equal pressure, the locomotive, though labouring against the heavy counter-pressure of the blast from which the other is free, is assumed to have performed equal work with less than one-half the expenditure of power. That if the resistance assigned by Dr. Lardner as opposed to the progressive motion of the train be correct, the efficiency of the steam in the locomotive is more than double that obtained by the best condensing engines; more than treble that derived from

stationary non-condensing engines, and equal to the performance of a Cornish expansive engine, doing a fifty million duty with a bushel of coals. With such results before us, the resistances assigned as opposed to, and overcome by, the locomotive at different velocities, must be regarded as utterly inconsistent with reality, and as resting on no solid foundation. The preceding results show also that errors have crept in by the adoption of the theoretical method of reducing undulatory surfaces to a level. M. de Pambour extends the length of the road as a compensation for the acclivities, or for the help afforded by the bank engines, and Dr. Lardner diminishes the time of the trip to that which he assumes would be occupied in performing it on a dead level. If the principles on which these corrections for the acclivities and declivities are made be correct, other facts than we are at present acquainted with must be taken into account before it can be demonstrated that a given power will convey a given load at some certain increased velocity along a level, compared with the actual velocity along any given undulating line. The resistances which enter into the composition of the sum of the forces are ever varying to such an extent that it may be doubted whether the theoretical level be not a pure fiction with reference to the practical results of the experiment.

The effective power of a locomotive engine, or the excess of power after overcoming its proper friction and the resistance from the blast, is solely expended in the generation of momentum. This, which is the product of the mass and the velocity, represents the useful mechanical effort exerted by the steam, and may always be ascertained under all the practical circumstances of railway traffic. The consumption of power as water, in the shape of steam, is a third quantity which may also be readily ascertained. The application which may be made of the above data is comprehended in the following propositions. First, that equal momenta would result at all velocities from an equal amount of power expended in equal times by the same engine, if the forces opposed to progressive motion and to the effective use of steam in the engines were uniform at all velocities. Secondly, the difference between the momenta generated by a unit of power in a given time at various velocities, measures the difference in the sum of the resistances opposed to the power at those velocities. Having ascertained the gross weight of an engine, tender, and train—their mean velocity—and the expenditure of water as steam during the trip, simple computations will inform us of,

1. The mechanical effect realized by a given power at all velocities.
2. The total increase or decrease of resistance at all velocities.
3. The ratios which the increase or decrease of resistance at different velocities bear to the ratios of those velocities.

Two other results also follow from the above, and which may be termed the commercial results, viz. the amount of gross and useful tractive effect realized by an equal expenditure of power at all velocities. The difference between these is a useful quantity in a practical sense, being the costly waste of power incident to the locomotive functions of the engine and tender over and above the waste arising from the unascertained and ineffective portion of the whole power required for the blast. The reductions and computations necessary for the exhibition and development of these views are contained in two tables. They relate to forty-nine experiments, being those already referred to, and those by Mr. N. Wood, on the Great Western and London and Birmingham Railway, and some others. One of these tables contains the velocity of the engines, the consumption of water as steam,



the loads, the absolute momenta per second; the momenta generated by equal power in equal times, viz. by one pound of water as steam per second; the weights of the gross and useful loads moved by equal powers, viz. by one cubic foot of water as steam, at the velocity of each experiment, with various other elements. The other table contains a summary of the ratios of the velocities and of their squares, brought into juxta-position with the ratios of the power expended to produce equal momenta, equal gross and equal useful effects, by the comparison of pairs of experiments on the engines given in the preceding table. This table also shows the influence of velocity in the expenditure of power to produce equal mechanical and equal commercial effects; and the amount of loss attributable to the increase of resistance at the higher velocities. The author discusses in great detail the various circumstances of these experiments, and the inferences and practical conclusions which may be deduced therefrom: and comes to the conclusion, that the determination of the performance of the locomotive engines by the methods here set forth is as practicable, exact, and demonstrative of their relative powers and dynamic excellence, as the determination of duty done by pumping engines. The intensity of the pressure on the opposite side of the piston arising from the blast has been but imperfectly stated. By some, the discharge of the steam has been likened to a jet, and considered continuous. But an attentive observer can appreciate by his ear that an interval exists between the alternate discharges of steam from the two cylinders. That these jets are periodic and not continuous, is also distinctly evidenced by the audible pulsations in the chimney, even at the very highest velocities of an engine, and their duration may be measured at lower speeds. Upon this intermittent action of the blast depends, in a great measure, the resultant pressure against the piston, and the production of a sufficient current of air through the fire, both which effects would be materially changed in intensity by the substitution of a continuous for a periodic current. The precise duration of the jet, or of the time of the steam evacuating the cylinder, can only be determined by direct and careful experiments; but its period may be ascertained within definite limits; for since a single discharge is completed within the time occupied by the piston in accomplishing a half stroke, and the pauses between two successive discharges are distinctly preceptible, a single blast cannot occupy the fourth part of the time of the revolution of the crank shaft, and very probably does not exceed the eighth part, or the period of a quarter stroke of the piston. Under no circumstances, then, can the pressure from the blast oppose the piston much longer than during one-fourth of the stroke. With an active pressure, then, of 30 lbs. per square inch, the mean resistance from the blast would not be greater than seven and a half pounds, and with a pressure of fifteen pounds not greater than three and three-quarter pounds per square inch, against the pistons. The author then proceeds to cite several observations and experiments made by himself, which are confirmatory of the preceding argument respecting the blast, and he was led conclusively to the fact, that one-fifth of the power of the engine experimented upon, at working pressures of twenty pounds and fifteen pounds was absorbed in blowing the fire; and that the escape of the steam from the cylinder was four times swifter than the motion of the piston.

The author lastly treats of the expenditure of power for a given effect, by fixed and locomotive non-condensing engines. But few experiments on the expenditure of steam for a given effect by non-condensing stationary engines have been made. The relative consumption of fixed condensing and non-condensing engines has been treated of by the late Mr. Charles Sylves-

ter, of Derby, whose knowledge and accurate theoretical analysis of the subject are shown by the close accordance of his conclusions with the facts established on two engines of these classes at certain working pressures. His conclusion that the relative economy of these engines will be as the quantities of steam consumed, or as 1 to 1.76 at those pressures, is accurately confirmed by the results he recorded. Mr. Sylvester also showed, that by increasing the pressure upon the same non-condensing, and by enlarging the area of the condensing engine's cylinder and air pump, so as to maintain the steam in it at a uniform pressure per square inch for all loads, the economy of the former would gradually approach and finally equal that of the latter. The results obtained in the preceding part of the paper furnish numerous comparisons between the locomotive and fixed non-condensing engines, and the consumption of the latter has been used, together with the condensing engine, as the test of the accuracy of the data of resistance assigned to the former by the various analysts. The accurate determination of the expenditure of steam by the same locomotive engine, in which the values of the friction and of the blast pressure were ascertained, admits of the consumption of water as steam for given effects being determined, and thus narrows the grounds of doubt, and establishes more correct data for ascertaining the real resistance opposed to progressive motion on railways. The application of these principles, as borne out by the experiments of the author, and their particular bearing on the experiments which have been the subject of the previous ample and detailed discussion, form the conclusion of Mr. Parkes' series of communications on steam boilers and steam engines.

Athenæum.

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*Steam Conveyances on Common Roads.*

A new company has been formed in London, for the promotion of this object, entitled the "Macaroni Common Road Steam Conveyance Company." The first report of the Committee was read at a meeting of the friends of the Company on the 29th of January. It states that "In a committee of the House of Commons in the year 1839, a most minute examination of the question had taken place, and evidence in favor of the plan, which this company is formed to carry out, had been received, whereupon Mr. Mackinnon (the chairman of that committee) observed that "the evidence respecting Col. Macaroni's invention, was most satisfactory and conclusive. He was very glad that evidence had been received, as it would greatly assist the committee in recommending a means of saving the main roads, and the interests connected with them from the ruin with which they were threatened." It was in accordance with those views the company had undertaken to introduce steam conveyance on the common roads; and it was with no small pride the committee had to announce that a carriage constructed on the principle of Col. Macaroni's invention was about to start, which would at once satisfy the shareholders and the public, and lay the foundation for its adoption by every coaching establishment throughout the kingdom. But to facilitate a speedy, uniform, and general adoption of steam conveyance upon common roads, a large and liberal aid on the part of those whose interest would be advanced thereby, was necessary. Of such aid the committee had the most positive assurances, for the road interests had by this time discovered that it was only by the common road steam-carriage, their property could be preserved, and their traffic maintained. Throughout the

country the coach proprietors, the innkeepers, and the very large body of persons who are interested in turnpike trusts, as well as the inhabitants and proprietors of every species of property upon and contiguous to the public lines of road, are at this moment looking forward with anxious hope to the success of this company, as the means whereby their activity shall be revived, and their interests preserved from ruin. A patent had been obtained for Col. Maceroni's invention, and a carriage is in course of completion at Mr. Beale's factory, at East Greenwich; and the committee are convinced that they will shortly be able to make arrangements for bringing the steam-carriages into general use, without calling for the full amount of capital suggested in the prospectus.

Col. Maceroni, in returning thanks for the toast with which his name had been coupled, said that in the course of the last twenty years many people had attempted to produce a steam-carriage that would run upon a common turnpike-road, and of these the most clever were those which had the least good luck. The principal amongst them was a Mr. James, of Birmingham, who was followed by Mr. Gurney. He, (Col. Maceroni,) had assisted the latter for about six months, until he was convinced that Mr. Gurney's plan was a failure altogether. He had served an apprenticeship, but all that he had learned was to avoid the errors of others. He had found that there must be no smoke—no noise—no chimney—and no ashes flying about. He had been asked by many editors of newspapers to give them an account of what his carriage could do. But he had invariably refused to do so, and always told them to come and ride with him, that they might judge of his performances for themselves, with their watches in their hands. The Colonel, having briefly sketched the history of his carriage, sat down amidst much applause.

Mr. Hodgson said the public would see that those carriages would maintain the traffic upon the common roads, without the dreadfully ruinous expense of the railways, and would carry them from village to village, and from town to town, by the established routes. He himself had been sceptical as to the practicability of the Colonel's plans; but upon examining the mass of evidence which appeared in support of them, conviction had been carried to his mind, and he became a sincere admirer of the invention. It was not from any knowledge of his own, his judgment had been formed, but it was from what he had seen of the evidence given upon oath, by persons who were above suspicion, who were amongst the highest rank, and the most eminent in science that this country can boast of, that this invention of Maceroni's had been satisfactorily tried and had been amply successful. He would ask, what man could doubt the complete success of the carriage, after the decided and conclusive testimony given in its favour by the Marquis of Tweeddale, before the committee of the House of Commons in 1839? But it was not to be wondered at, that that conviction had not been extended more widely, that it was obstructed by that prejudice to which he had before referred, when they remembered that not many years had passed since six British Admirals, upon mature deliberation, solemnly pronounced that steam navigation upon the high seas, was quite impossible, and now they saw those magnificent steam-ships, of thousands of tons burthen, traversing the Atlantic with as much ease and certainty as others navigated the Thames, or crossed the British Channel.



*"On the Expansion of Arches."* By G. RENNIE, Esq.

The expansion of solids, which has excited the attention of mathematicians since the investigations of La Hire, in 1688, on a rod of iron, is of particular importance in the construction of bridges, the security of which may be effected by the dilatation and contraction consequent on changes of emperature. Periodical motions, referable only to changes of temperature, were observed by Vicat, in a stone bridge built over the Dordogne, at Souillac, and have frequently been noticed in structures of all kinds. The different expansibilities of stone and iron have been considered an objection to the use of cast iron pillars in connexion with stone, to support the fronts of buildings; but the experiments of Mr. Adie, of Edinburgh, led him to the conclusion, that no danger is to be apprehended from a change of temperature affecting cast iron and sandstone in any great degree, as their expansion, so far as regards buildings, may be considered the same. Arguments from his source were employed against the arches of Southwark Bridge, and the experiments set forth in this communication were undertaken with a view of ascertaining the effect of temperature on these arches. Three sets of experiments were made, the first in January, 1818, when the main ribs and diagonal braces rested on their centres, and before any of the spandrels and road plates had been put upon them; the second, in August and September of the same year. The rise was measured by the insertion of small wedges, by which the rise was ascertained to about  $\frac{1}{40}$ th of an inch. The most extensive set of experiments were made on the eastern arch. Great care was taken in observing the thermometers, of which there were three, one in the open air, another among the ribs, and the third inserted in the iron of the rib. The result of nine experiments gave, as a mean, a rise of  $\frac{1}{40}$ th of an inch for  $1^{\circ}$  Fah. The effects of changes of temperature were also observed in the stone bridge, over the Thames, at Staines; after the arches had obtained their full settlement, openings were observed in the joints of the parapets immediately over the springing of the arches, and a distortion, or sinking, of the upper curve of the parapets. A wedge was inserted into some of these openings and the lowest point of its descent, in the month of January, marked. The same wedges were carefully inserted every week until May, when they would no longer enter, and the joints became firmly closed. At this period, however, the joints immediately over the crowns of the arches which had, during the winter, been quite close, were open. From these facts it followed, as a necessary consequence, that in winter the arch contracting descended, and the spandril joints opened, and in summer the arch expanding rose, and closed these joints, and opened those at the crowns. Thus the joints of the parapets, which were made of single slabs of granite for the whole height, became good indicators of the changes of temperature. It had also been observed in the Waterloo and other bridges, that joints made good in the winter with Roman cement were found crushed in summer. The details of these experiments, and of others, on the expansion of a large portion of the rieze plate, and the calculations to which they give rise, occupy the principal portion of this communication.

Athenæum.

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*Exports and Imports of Metals in England.*

We have before us the annual statement of imports and exports of metals  
VOL. XXV.—No. 5—MAY, 1840.

30

furnished us by Mr. John Richards, to which we referred in an earlier number, and now present to our readers an abstract, carefully made, which will be found useful, while we must refer those anxious for further details to the document itself. It appears that the exports for the past two years are as follows:—

| EXPORTS.       |   |                |           |           |           |
|----------------|---|----------------|-----------|-----------|-----------|
|                |   | 1838.          | 1839.     | Increase. | Decrease. |
| Iron,          | - | tons 102,766   | 112,559   | 9,793     |           |
| Steel,         | - | - 1,478        | 2,738     | 1,260     |           |
| Copper cakes,  | . | . 3,577        | 3,252     |           | 325       |
| Copper sheets, | - | - 5,412        | 6,205     | 793       |           |
| Tin blocks,    | - | - 3,871        | 2,931     |           | 940       |
| Tin plates,    | - | - 218,323      | 197,980   |           | 20,343    |
| Lead,          | - | - 9,100        | 9,378     | 278       |           |
| Spelter,       | - | - 1,858        | 3,391     | 1,533     |           |
| Quicksilver,   | - | lbs. 2,360,672 | 2,423,081 | 62,409    |           |

From which it will be seen that the increase in the exports of iron, on that of the preceding year, is about nine and a half per cent.; steel eighty-five per cent.; copper in sheets and nails, fifteen per cent.; lead three per cent.; spelter eighty-two per cent.; and quicksilver nearly three per cent.; while in cake copper, the decrease has been about ten per cent., and there has been also a decrease in tin blocks and plates—in the former to the extent of twenty-four per cent., and the latter about nine per cent.

The imports for home consumption for the past three years are thus enumerated:—

| IMPORTS.     |   |              |         |         |                             |
|--------------|---|--------------|---------|---------|-----------------------------|
|              |   | 1837.        | 1838.   | 1839.   | Increase<br>last 12 months. |
| Iron,        | - | tons 11,477  | 17,301  | 18,516  | 1215                        |
| Steel,       | - | -            | -       | 23      | 23                          |
| Copper,      | - | - 110        | 171     | 13      | 158                         |
| Tin,         | - | -            | 2       | 1       | 1                           |
| Lead,        | - | - 10         | 85      | 12      | 73                          |
| Spelter,     | - | - 2,335      | 3,506   | 4,760   | 1254                        |
| Quicksilver, | - | lbs. 309,099 | 409,580 | 331,247 | 78,333                      |

Showing an increase of nearly seven per cent. on iron, and twenty-six per cent. on spelter, in the year ending 1839, or upwards of fifty per cent. on the former, and one hundred per cent. on the latter, in the two past years. The decrease has principally been in quicksilver, which shows a diminution of about twenty-five per cent., while it should, however, be remarked, that the excess of stock in London on 1st January, 1840, over that of 1st January, 1839, is 140,000 lbs.

We do not propose, on the present occasion, to draw any deductions from the abstract made from the statement referred to, but doubt not that the figures will afford ample scope for correspondents to remark on our imports and exports of the past year, compared with those preceding.

Mining Jour.

### *On the Cause of Steam Boiler Explosions.*

Sir,—All the writers on steam-boiler explosions appear to have either for-

gotten or not to have been aware of one, if not the principal, cause of them. Persons accustomed to the operation of heating any liquid in close vessels, know, that under a considerable pressure, the intumescence within the boiler, in the bubbling up of the liquid, is checked to such an extent as to render it nearly motionless. Now let us see in what state water exists in steam-boilers with a moderate pressure on the valve. Steam and water is then in a state of intimate admixture throughout the whole mass, and the former is ready to escape, not only from the surface, but from all parts of the body of the water, on the removal of the pressure. In this tendency to escape, the steam of course cannot rush to the surface, but by carrying with it a considerable mass of the water (which surrounds and imprisons the steam) to a certain height. We will, therefore, now suppose that the pressure in the boiler is sufficient to raise the valve a little—the spring of the steam within instantly occasions a violent ebullition, and whilst there is sufficient vacant space in the boiler above the surface of the water, so that the bubbles of water may break and set free the imprisoned steam before they fill completely the vacant space, or touch the valve, it may admit an escape of the steam in sufficient quantity to carry off all the caloric which the fire underneath is supplying to the boiler every moment of time—but suppose the ebullition to become so violent on the raising of the valve as to project water and steam together through it, what is the consequence? As it is well known that steam issuing from any aperture will carry off 1000 degrees of heat, or nearly five times as much as water in similar circumstances, if the valve does not, in such an event, open to five times the space it did before, in proportion to the quantity of water, (mixed with steam) required to pass through it, the heat must accumulate in the boiler, and the pressure be consequently augmenting, notwithstanding the valve is acting, until an explosion ensues.

Thus what appears to be a paradox, is certainly true, that a valve which might be quite safe by a partial opening would become unsafe by a greater one—that is, whilst *steam alone* is passing through it, a much greater quantity of caloric is escaping than when, by a greater opening, the ebullition should be so increased as to raise the water also, and thus partially choke the aperture. It therefore follows that it is dangerous to allow a valve to open too suddenly and widely, and that it is much safer to put such a stop on it, as will so regulate the aperture that the ebullition within the boiler shall be restrained to the extent of not mounting so high as the valve, the lift of which, necessary for this purpose, depending as it does on the form of the boiler, the pressure at which it is worked, and the quantity of water in it, can only be ascertained by experience.

Bristol, Feb. 20, 1840.

H. A. M.  
London Mech. Mag.

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*“Observations on the efficiency, or gross power, of Steam exerted on the Piston in relation to the reported duty of Steam Engines in Cornwall at different periods.”* By J. S. ENYS.

The advantages which may result from the union of scientific and practical knowledge in the application of steam power, particularly with reference to the limits of gross power, are great, as likely to check the extravagant notions entertained by some with respect to the farther increase of duty, and to remove the disbelief of others with respect to the amount of duty actually performed. The limit of duty for atmospheric steam may be readily arrived at,



as was done by Mr. Davies Gilbert, in 1827, by estimating the weight of water which would rise thirty-four feet into a vacuum formed by the condensation of steam of atmospheric strength; whence it appears, that a higher duty than thirty millions cannot be obtained by atmospheric steam, fourteen cubic feet of water being evaporated by a bushel of coal. Tredgold, in the first edition of his *Treatise on the Steam Engine*, published in 1827, adopted the simpler method of multiplying the volume of steam of atmospheric strength by the pressure, for the measure of the efficiency: this principle may be extended to measure the efficiency of steam at higher pressures. The author then proceeds to show, that the Cornish engines are worked under such conditions that a large proportion of the expansive action of the steam is available on the piston, and calls attention to two necessary corrections,—first, for the deficiency of water in high steam cut off at one-fifth of the stroke; and second, for the increase of temperature of the steam during expansion in the cylinder, as derived from the steam jacket. The experiments of Mr. Wicksteed, confirmatory as they are of the very extended experiments made by Woolf at Wheal Alford, show the importance of this latter correction. Some error has also arisen from the use of the boiler pressure. The exact determination of the pressure in the cylinder is difficult, and the only recorded experiments are those by Mr. Henwood with the common indicator, and published in the second volume of the *Transactions of the Institution*. The quantity of water evaporated was very imperfectly recorded; it was stated by Watt as from eight to twelve cubic feet per bushel, and at present may be stated at about fourteen cubic feet, but is sometimes, with good coal and careful stoking, much higher. The author briefly alludes to the progress of improvement in Cornwall; the introduction by Woolf of high steam; the substitution of the plunger pole for the bucket pump, and the application, so recently made by Mr. James Sims, to stamping or crank engines of the arrangements which had been a long time so advantageously used in pumping engines.

Athenæum.

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### *Great Western Electric Telegraph.*

On Saturday last the following members of the select committee of the House of Commons on railways, inspected, by appointment, the electro-galvanic telegraph, at the Great Western Railway station, at Paddington, which extends from thence to West Drayton:—The Earl of Lincoln, Viscount Sandon, Sir Harry Verney, Bart., Lord Granville Somerset, Mr. Hume, Mr. Lock, and Mr. Greenc. There were also present Sir E. H. Alderson, Mr. Russell, the chairman of the company, Sir J. Clark, and several gentlemen connected with mechanical and scientific pursuits. Messrs Cooke and Wheatstone (the inventors) were in attendance, and explained to the committee the principle of the working of the telegraph, and its application to the purposes of government and commerce, as well as railways. The party was engaged upwards of two hours in inspecting its mechanism and working, and appeared to attach great importance to an invention which seems destined to produce great changes in our internal communications, by its rapid and almost instantaneous agency. The Blackwall Railway Company have just adopted, the electro galvanic telegraph on their line, which is now being laid down on an improved plan, adapted to the method of working the trains by stationary engines.

Min. Jour.

*A Brick Machine.*

A newly-invented brick machine has, for the last few days, been at work at the premises of Messrs. Fawcett, Preston, & Co., the highly respectable engineers of Liverpool, who have expressed their most entire and unqualified approbation of the merits of the invention; we have seen it in operation at their yard, and can bear testimony to the remarkable soundness and squareness of the bricks which it produces. Architects and builders cannot but recommend them, in preference to all hand-moulded bricks, as they are smoother and less pervious to the wet and damp, and the more capable of sustaining heavy weights. The process is very simple; the clay, after being saturated with water, is wheeled into the pugmill, worked and tempered by the machine, forced therefrom into common moulds, which pass underneath, and the bricks are delivered on boards ready to be removed to the drying ground. One horse will temper clay for, and mould 1,500 bricks in one hour; and such is the simple nature of the machine, that it is not liable to get out of repair.—*Gore's Advertiser.*

Ibid.

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## Progress of Physical Science.

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*Murchison's Silurian System.*

Mr. Murchison is well known as one of the leading founders and honorary officers of the Geological Society of London; and the eminent position which that society at present occupies in public estimation is in a great degree attributable to his exertions. But he is equally known to all European geologists as one of the most indefatigable votaries of the science; and the examination which for many years past he has been engaged in prosecuting, of the border counties of Wales and England (the Siluria of Caractacus,) has long been looked to, both by British and continental geologists, with great interest. It is, then, through Mr. Murchison's labours, carried on with a patience and assiduity worthy of all praise, during the last nine or ten years, that the fact has been at length established of the existence of a complete and very extensive series of fossiliferous strata, interpolated between the old red sandstone and the older slaty rocks. To this system, which rises to the surface in successive ridges in the border counties of Wales and England, and presents a normal type of hitherto unclassified deposits, its discoverer has affixed the name (now generally accepted by geologists) of *Silurian*. Shortly after the period when Mr. Murchison first announced his intention of devoting his energies to the survey of this important link in the chain, Mr. Sedgwick undertook to investigate the older and contiguous transition rocks of Wales, to which he gave the name of *Cambrian*. And we have every reason to hope, from the professor's well-known powers of observation, and the samples already offered to the society, that geology will, before long, be largely benefitted by the publication of the results of his researches. Mr. Murchison hints at the possible existence of coal-measures, capable of being advantageously wrought, beneath much of that great area of this island which is covered with the new red sandstone strata. That the coal, if reached in this situation, would in all cases pay the cost of exploring it, is of course uncertain; "and therefore," pursues our author, "believing that beneath the tracts of new red sandstone surrounding the coal-fields there may exist a due proportion of thick and valuable,

as well as of thin and profitless, coalseams, let me advise the proprietors of such tracts, before they embark in mining, to ascertain the exact geological position of the red land on which they live. If it should belong to the upper, or even to the middle portion of the new red sandstone, they would do well to desist. If, on the contrary, it should belong to the *lower* new red—and, above all, if the spot be not very far distant from the edge or boundary of a good coal-field, then let the trial be fearlessly made. But the speculator must bear in mind that coal, like every other mineral substance, is distributed in layers of variable thickness, and may, therefore, rapidly attenuate, as well as suddenly expand, within a very limited area. A remarkable example of this phenomenon has been exposed by the works at West Bromwich. This enterprise has indeed completely confirmed the geologist's view, by showing the existence of a carbonaceous formation beneath the new red sandstone; but we must fairly acknowledge that, as an experiment to prove the existence of a good *commercial coal-field* extending towards the town of Birmingham, it has for the present failed. In the meantime, the shafts of Lord Dartmouth being nearly one mile distant from what was anciently supposed to be the edge of the coal-field, where the ten-yard coal is cut off by a fault, there is every rational ground for believing that the work, when followed to the west, or towards the known coal-field, will amply repay the outlay of this spirited enterprise. The application of this principle to certain tracts on the northern and eastern sides of the coal-fields of Coal Brook Dale, and generally around the Staffordshire and Worcestershire coal-fields, must be obvious to all who have perused the preceding pages. I press the consideration of the extension of coal-measures beneath the new red sandstone of the central counties, because, though absolutely essential to a correct calculation of the probable duration of British coal, it has been entirely omitted in our national estimates. Hence political economists may be led to appreciate the value of geological inquiry.”—The second part of Mr. Murchison's work contains a description and catalogue of the organic remains by which he has succeeded more especially in identifying and distinguishing his “Silurian system” from other earlier formations. Elaborate engravings are given of about 350 species, three-fourths of which are *new* to the scientific world, and it is upon this that the chief merit of our author's labours is based, since he demonstrates that, independently of all local or mineral distinctions, these Silurian rocks contain vast quantities of organic remains—a *fauna* of their own—totally distinct—except in a very few individual instances, from the fossils of the overlying systems. It is by the establishment of this fact that he is authorised to claim for his *system* the remarkable individuality and extension of character which justifies its separation from all the earlier deposits, and has enabled other geologists already to identify it in other parts of the earth's surface, of which it constitutes, according to recent information, a not inconsiderable portion. The evidence thus brought forward affords an additional proof of the important truth which, as we said above, geology had already established—that each great period of change, during which the surface of our planet was essentially modified, was also marked by the successive production and obliteration of certain races of animated beings. Not that every ancient formation was tenanted by creatures *absolutely* peculiar to it; the large natural groups of strata only (or, so to speak, systems) can be thus distinguished; but every great movement of newly deposited matter—every considerable change in the character of the deposit—was accompanied by the appearance of new races, and the destruction, and total vanishing from the face of the earth, of the great



mass of those species which previously lived, and moved, and had their being there, but whose construction or habits were probably unfitted for the new state of things which the progress of great physical revolutions had brought about. And the evidence of this fact is not confined to one locality, but is general to the whole surface of the globe which has been as yet investigated by geologists. We do not mean that these changes were everywhere synchronous: no doubt, while one district was undergoing rapid mutations, both of its mineral structure and organised existences, others were for the time stationary and quiescent, as is notoriously the case at present. But sooner or later, changes of similar character invaded these quarters also; and there is every reason to believe that, within periods of considerable extent, every part of the earth's surface was in turn subjected to analagous variations of its physical condition, giving rise to analagous changes in its organic life.—*Quarterly Review*.

Mining Rev.

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*Researches on Fluorine. By G. J. KNOX, M. A., M. R. I. A.*

1. *On the Insulation of Fluorine.*

"In a paper on the Insulation of Fluorine which the Rev. Thomas Knox and I had the honor of presenting to the Royal Irish Academy in the year 1837, and which was afterwards published in their Transactions, (vol. xviii. p. 127,) we proved that we had obtained fluorine in an insulated state, by showing its action upon bismuth, palladium, and gold; but being unable, from our mode of experimenting, to determine what the nature of fluorine at ordinary temperatures might be, i. e. whether it be a solid, a liquid, or a gas, we suggested that such information might be obtained from the electro-lization of fluorine, using as the positive electrode some substance with which this energetic principle should not enter into chemical combination.

"Finding that, since the publication of our paper, no person had entered upon this field of investigation, I considered that the ultimate solution of this problem devolved as a point of duty upon myself; under which impression I undertook the following experiments.

"A fluor-spar stopper was made to fit the mouth of one of the fluor-spar vessels described in our former paper; that part of the stopper within the vessel being made of the form of a semi-cone, the vertex of which reached nearly to the bottom of the vessel. Through the stopper were drilled, vertically, three small holes, one through its entire length, the other two through one-third of its length. In the first was inserted a platinum wire, to be used as the negative electrode; in one of the two small holes was inserted a thin platinum wire, bound round a piece of charcoal, intended to form the positive electrode; in the other hole I put gold-leaf, litmus, or any other substance upon which I wished to try the action of the gas. Matters being so arranged, the fluor-spar vessel was about half filled with anhydrous hydrofluoric acid, the chemical purity of which had been previously ascertained. The platinum wire forming the negative electrode was raised a little above the bottom of the stopper, in order to allow the bubbles of hydrogen to rise through the perforation in the stopper, in place of mixing with the fluorine in the vessel; the wires were then placed in contact with the poles of a constant battery of sixty pair of plates, and the action was allowed to continue for the space of two hours; at the end of which time the litmus was found to be reddened, and the gold not acted upon, but a large quantity of sub-fluoride of iron formed.

In the next experiment I made use of a piece of charcoal, from which the iron had been removed by boiling it in nitric acid; in this experiment there was no subfluoride of iron formed, but the vessel was found to contain fluosilicic acid gas.

In a third experiment a piece of charcoal was employed, which had been previously freed from all metallic impurities and from silica, by being first boiled in pure nitric acid, and afterwards in hydrofluoric acid. Employing this purified charcoal as the positive electrode, I obtained no *immediate* action upon the litmus paper; but after the action had continued for two hours, it was found to be completely bleached, while the gold had undergone no sensible action. That the bleaching was not due to the action of the vapour of hydrofluoric acid was ascertained, by leaving litmus paper for several hours in the neck of a platinum retort, from which hydrofluoric acid was distilling.

The battery was now kept in action for fifteen hours, at the end of which time the vessel being examined, the litmus had disappeared, and the gold-leaf showed signs of having been strongly acted upon, having assumed a dark brownish colour, and having gathered itself into little balls, as if it had undergone the action of heat. The platinum wire was acted upon in those parts where it was in contact with the charcoal, but nowhere else.

When the platinum wire forming the positive electrode passed through the stopper to the bottom of the vessel, the hydrogen, in place of rising through the perforation in the stopper, as in the former instance, rose into the receiver, where, upon applying a light, it exploded, showing that it does not enter into combination with fluorine without the aid of heat. The presence of the vapour of hydrofluoric acid in the vessel prevented me from determining by other experiments how far fluorine was a supporter of combustion.

To determine the colour of the gas, a stopper of fluor-spar similar to the former was made to fit one of the transparent fluor-spar receivers formerly described. The gas evolved in the receiver appeared colourless.

As the action of the gas upon glass could not be determined, owing to the presence of the vapour of hydrofluoric acid, I fused in a bent tube of German glass (such as is used in organic analysis) fluoride of lead. The wire holding the charcoal was made to pass through a cork inserted in one end of the tube, the other platinum wire merely dipped into the fused fluoride. On connecting the wires with the battery, strong electrolytic action commenced, bubbles of gas were evolved rapidly at the surface of the charcoal, which, on arriving at the surface of the fused fluoride of lead, acted instantly upon the glass. The litmus paper was not bleached, nor the gold-leaf or platinum wire acted upon. Whether fluorine would act upon perfectly dry cold glass remains to be proved.

*Conclusion.*—Fluorine then, when obtained in an insulated state, is a colourless gas, possessing properties analogous in all respects to those of chlorine; having, like it, strong attractive powers for hydrogen and metals, but inferior to it in negative electrical energy.

## 2. Note on a Compound of Fluorine with Selenium.

When the vapour of selenium is passed over fluoride of lead fused in the platinum apparatus which I employed in obtaining the fluorides of carbon and cyanogen, a seleniuret of lead is formed, and crystals similar in form to those of fluoride of carbon are condensed in the cold receiver. These crystals are soluble in strong hydrofluoric acid. They sublime unal-

tered at a high temperature. They are instantly decomposed by water or acids, in which property they resemble the fluorides of sulphur and phosphorus.

Lond. & Edin. Philos. Mag.

*On a simple mode of obtaining from a common Argand Oil Lamp, a greatly increased quantity of Light: in a letter from SIR J. HERSCHEL, Bart.*

GENTLEMEN,—The following simple, easy, and unexpensive mode of greatly increasing the quantity of light yielded by a common Argand burner has been used by me for some years, and is adapted to the lamp by which I write, to my greatly increased comfort. It consists in merely elevating the glass chimney so much above the usual level at which it stands in the burners in ordinary use that its lower edge shall clear the upper edge of the circular wick by a space equal to about the fourth part of the exterior diameter of the wick itself. This may be done to any lamp of the kind, at a cost of about sixpence, by merely adapting to the frame which supports the chimney four pretty stiff steel wires, bent in such a manner as to form four long upright hooks, in which the lower end of the chimney rests; or, still better, if the lamp be so originally constructed as to sustain the chimney at the required elevation without such addition, by thin laminæ of brass or iron, having their planes directed to the axis of the wick.

The proper elevation is best determined by trial; and as the limits within which it is confined are very narrow, it would be best secured by a screw motion applied to the socket on which the laminæ above mentioned are fixed, by which they and the chimney may be elevated or depressed at pleasure, without at the same time raising or lowering the wick. Approximately it may be done in an instant, and the experiment is not a little striking and instructive. Take a common Argand lamp, and alternately raise and depress the chimney vertically from the level where it usually rests, to about as far above the wick, with a moderately quick but steady motion. It will be immediately perceived that a vast difference in the amount of light subsists in the different positions of the chimney, but that a very marked and sudden *maximum* occurs at, or near, the elevation designated in the commencement of this letter: so marked indeed as almost to have the effect of a flash if the motion be quick, or a sudden blaze as if the wick-screw had been raised a turn. The flame contracts somewhat in diameter, lengthens, ceases to give off smoke, and attains a dazzling intensity.

With this great increase of light there is certainly not a correspondingly increased consumption of oil. At least the servant who trims my lamp, reports that a lamp so fitted consumes very little if any more oil than one exactly similar on the common plan.

Ibid.

### Manufacture of Chlorate of Potash.

M. Pelouze has communicated a new and advantageous mode of preparing chlorate of potash. Hitherto carbonate of potash has always been decomposed by chlorine. M. Pelouze describes the inconveniences of this process, which he proposes to remedy by substituting soda for potash; by this chlorate of soda and common salt are obtained, and the chlorate of soda is converted by double decomposition into chlorate of potash by one of the cheap salts of potash which occur in commerce.

M. Pelouze also proposes to pass chlorine into milk of lime, by which



chloride of lime is obtained, and this is then decomposed by chloride of potassium.—*L' Institut*, No. 318.

Ibid.

### *Galle's Three Comets.*

The following statement is furnished by a contributor to the *Journal of the Franklin Institute* whose scientific accuracy is always worthy of confidence.

"Mr. Galle, assistant observer at the Royal Observatory of Berlin, has discovered three comets in the short space of three months.

The first was discovered on the 2d of December last, passed its perihelion January 4th, and was visible to the naked eye for a few nights in January as a nebulous star of the 5th magnitude.

Galle discovered his second comet on the 25th of January; it passed its perihelion on the 12th of March, and, owing to the early arrival of Professor Encke's computation of its elements, it was seen at several places in the United States: Hudson, Ohio, Philadelphia, New Haven, &c., without, however, being visible to the naked eye.

These two comets are considered as new discoveries. Their elements do not agree with those of any that have yet been observed. Their motions may be perfectly represented by supposing them to move in a parabola, a curve which does not return into itself; so that no plausible conjecture can be formed respecting the time of their past or future appearances, except that the period of their revolutions cannot be much short of a thousand years.

Galle's third comet was discovered March 6th, and passed its perihelion on the 2d of April; its tail (visible only in a telescope) might be traced through several degrees. Its elements, compared by its discoverer in connexion with Encke, shew that it is the same as that which appeared in 1097 and 1468, and that its period is about 370 years. Its two last appearances occurred in the autumn, when it passed much nearer the earth, and hence its greater brilliancy. Neither of these comets is visible at present, the first is too remote from the earth, and the last two are lost in the morning twilight."

### *Iron Pyrites and Calamine.*

This mineral, which is composed chiefly of iron and sulphur, and is produced in considerable quantities from some of the Derbyshire lead mines, promises, in consequence of the high price of sulphur, to be in some request. It has hitherto been considered as deads, or rubbish, and has been thrown away as such. Some gentlemen have been making inquiries for the article (known here as brazil or mundic) at Matlock, and twenty tons have been forwarded to their works, selected from the old hillocks of the Oxclose mine, at Snitterton, and the company express themselves willing to take any quantity that can be collected. Inquiries have also this week been made after calamine (*lapis calaminaris*), and arrangements are in progress which may probably lead to a market being again opened for this once important article to the miner. Calamine is abundant in the neighbourhood of Bonsall and Matlock, and as much as 3000*l.* annually have been paid for the article in Bonsall alone; but, owing to the introduction of a foreign article, the price has of late years so much declined as to make it (except in a very few instances) no longer worth working for.—*Derbyshire Courier*.

Mining Jour.

## Mechanics' Register.

### *Novel Mode of Conveying a Steam Engine.*

It is but a short period that the Steam Engine has been used to convey Post letters on land, and now for the first time a Post letter is made the means of carrying a Steam Engine.

Messrs. Newton and Barry, of the Patent Office, Chancery lane, London, have this morning received per post, from Messrs. Chadburn Brothers, Sheffield, a perfect working steam engine, constructed on the oscillating cylinder principle, with its fly-wheel, framing, boiler, and fire place complete; the whole was enclosed in a case wrapped in paper secured with a string, accompanied with a description of its construction and mode of working. The total weight being under four ounces, was charged as eight letters, which sum being *pre-paid* at Sheffield, cost eight pence postage, and came safe to hand with its fellow penny travelers.

We understand that Messrs. Bailey, of Holborn, received last week, per post, a proof impression of an embossed metal plate, which being under half an ounce, was directed on its surface—*pre-paid* at Birmingham, and delivered as a penny post letter. Query.—How did the post-master put the post-office stamps upon it?

*Chancery Lane, January 29th, 1840.*

London Jour. Arts & Science.

### *Platina Wires for Musical Instruments.*

A musical composer, named Fischer, has proposed the substitution of platina wires for those of steel or brass. It is (he says,) more elastic and ductile, and the sounds produced by this metal are sweeter; air and damp do not act upon it, and as it combines with iron, cords might be made of a composition of the two, which would present the advantages of each.

*Athenæum.*

Mech. Mag.

### *Gas Lights in London.*

For lighting London and its suburbs with gas, there are—

18 public gas works.

12 do companies.

2,800,000*l.* capital employed in works, pipes, tanks, gas-holders, apparatus.

250,000*l.* yearly revenue derived.

180,000 tons of coals used in the year for making gas.

1,460,000,000 cubic feet of gas made in the year.

134,300 private burners supplied to about 40,000 consumers.

30,400 public or street do. N. B. about 2650 of these are in the *city* of London.

380 lamp lighters employed.

176 gas holders; several of them double ones, capable of storing 5,500,000 cubic feet.

890 tons of coals used in the retorts on the shortest day, in 24 hours.

7,120,000 cubic feet of gas used in the longest night, say 24th December.

About 2500 persons are employed in the metropolis alone, in this branch of manufacture.

Between 1822 and 1827 the quantity nearly doubled itself, and that in five years.

Between 1827 and 1837 it doubled itself again.

*Ibid.*

| LUNAR OCCULTATIONS FOR PHILADELPHIA,<br>JULY, 1840. |      |      |                   |      | Angles reckoned to the right or<br>westward round the circle, as seen<br>in an inverting telescope.<br>☞ For direct vision add 180° ☛ |                        |
|-----------------------------------------------------|------|------|-------------------|------|---------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Day.                                                | H'r. | Min. | Star's name.      | Mag. | From Moon's<br>North point.                                                                                                           | From Moon's<br>Vertex. |
| 23                                                  | 11   | 30   | * Im. g Pleiadum, | 5, 6 | 102°                                                                                                                                  | 57°                    |
| 23                                                  | 12   | 16   | Em.               |      | 293                                                                                                                                   | 247                    |
| 23                                                  | 11   | 44   | * Im. e Pleiadum, | 5    | 133                                                                                                                                   | 89                     |
| 23                                                  | 12   | 27   | Em.               |      | 264                                                                                                                                   | 215                    |
| 23                                                  | 11   | 51   | * Im. c Pleiadum, | 5    | 103                                                                                                                                   | 58                     |
| 23                                                  | 12   | 38   | Em.               |      | 294                                                                                                                                   | 245                    |
| 28                                                  | 6    | 55   | Im. Venus' centre |      | 106                                                                                                                                   | 154                    |
| 28                                                  | 7    | 34   | † Em.             |      | 206                                                                                                                                   | 251                    |

\* Pleiades rise occulted, at 12h. 1m.

† Venus sets occulted at 7h. 22m.

### Meteorological Observations for February, 1840.

| Moon.                            | Days | Therm.             |           | Barometer.         |           | Wind.      |           | Water<br>fallen in<br>rain. | State of the weather, and<br>Remarks. |
|----------------------------------|------|--------------------|-----------|--------------------|-----------|------------|-----------|-----------------------------|---------------------------------------|
|                                  |      | Sun<br>rise.       | 2<br>P.M. | Sun<br>rise.       | 2<br>P.M. | Direction. | Force.    |                             |                                       |
|                                  |      |                    |           | Inch's             | Inch's    |            |           | Inches.                     |                                       |
|                                  | 1    | 23                 | 27        | 30.15              | 30.12     | N.         | Calm.     | .62                         | Snow—cloudy.                          |
| ☉                                | 2    | 7                  | 29        | .25                | .16       | NW.        | do.       |                             | Clear—do.                             |
|                                  | 3    | 15                 | 27        | 29.90              | 29.93     | W.         | do.       |                             | Clear—cloudy.                         |
|                                  | 4    | 5                  | 15        | 30.16              | 30.20     | W.         | do.       |                             | Clear—clear.                          |
|                                  | 5    | 4                  | 25        | .35                | .30       | S.W.       | do.       |                             | Cloudy—do.                            |
|                                  | 6    | 19                 | 43        | .20                | .14       | E.S.W.     | do.       | .17                         | Clear—rain.                           |
|                                  | 7    | 44                 | 48        | .00                | .10       | W.         | do.       |                             | Cloudy—clear.                         |
|                                  | 8    | 39                 | 42        | 29.96              | 29.96     | S.E. N.W.  | do.       |                             | Rain—do.                              |
| ☾                                | 9    | 36                 | 41        | .94                | .70       | W.E.       | do.       | .43                         | Cloudy—rains.                         |
|                                  | 10   | 49                 | 59        | .45                | .45       | E.S.W.     | do.       |                             | Fog—cloudy.                           |
|                                  | 11   | 30                 | 35        | .65                | .70       | N.W.       | Brisk.    |                             | Clear—do.                             |
|                                  | 12   | 24                 | 40        | 30.00              | 30.00     | W.         | Moderate. |                             | Clear—do.                             |
|                                  | 13   | 34                 | 49        | .00                | .15       | W.N.       | do.       |                             | Lightly cloudy—do. do.                |
|                                  | 14   | 34                 | 50        | .05                | .05       | E.         | Brisk.    |                             | Cloudy—rains.                         |
|                                  | 15   | 31                 | 37        | 29.95              | .10       | W.         | do.       |                             | Clear—do.                             |
| ☽                                | 16   | 24                 | 36        | 30.40              | .40       | N.S.       | Moderate. |                             | Clear—do.                             |
|                                  | 17   | 30                 | 44        | .20                | .22       | S.         | do.       |                             | Partially cloudy—do. do.              |
|                                  | 18   | 40                 | 43        | .20                | .20       | S.E.E.     | do.       | .50                         | Fog—rain.                             |
|                                  | 19   | 11                 | 54        | .20                | .29       | N.         | do.       |                             | Fog—do.                               |
|                                  | 20   | 48                 | 68        | .10                | 29.97     | S.W.       | Brisk.    | .4                          | Cloudy—shower.                        |
|                                  | 21   | 42                 | 52        | .30                | 30.30     | W.         | Moderate. |                             | Clear—do.                             |
|                                  | 22   | 31                 | 51        | .15                | .20       | E.S.E.     | Calm.     |                             | Clear—cloudy.                         |
|                                  | 23   | 54                 | 68        | 29.95              | 29.80     | S.W.W.     | Brisk.    |                             | Fog—hazy.                             |
| ☾                                | 24   | 44                 | 41        | .95                | .95       | N.E.]      | Moderate. |                             | Cloudy—clear.                         |
|                                  | 25   | 40                 | 41        | .90                | .90       | W.         | do.       |                             | Cloudy—clear.                         |
|                                  | 26   | 37                 | 61        | .90                | .80       | S.W.       | do.       |                             | Cloudy—clear.                         |
|                                  | 27   | 50                 | 52        | .85                | .85       | N.W.       | do.       |                             | Cloudy—do.                            |
|                                  | 28   | 28                 | 42        | 30.05              | 30.05     | W.         | do.       |                             | Cloudy—do.                            |
|                                  | 29   | 35                 | 58        | .05                | .05       | W.         | do.       |                             | Clear—do.                             |
|                                  | Mean | 32.79              | 44.58     | 30.01              | 30.03     |            |           | 1.72                        |                                       |
| Maximum height during the month. |      | Thermometer.       |           | Barometer.         |           |            |           |                             |                                       |
| Minimum                          |      | on 20th. and 23rd. |           | 30.40 on the 16th. |           |            |           |                             |                                       |
| Mean                             |      | 4.00 on 5th.       |           | 29.45 " 10th.      |           |            |           |                             |                                       |
|                                  |      | 38.6° 5            |           | 30.035             |           |            |           |                             |                                       |



### Hygrometer.

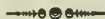
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**JOURNAL**  
OF THE  
**FRANKLIN INSTITUTE**

OF THE  
**State of Pennsylvania,**  
AND  
**MECHANICS' REGISTER.**

JUNE, 1840.



**Practical and Theoretical Mechanics and Chemistry.**

*Arts and Artisans at Home and Abroad: with sketches of the progress of Foreign manufactures. By JELINGER C. SYMONS, Esq., one of the assistant Commissioners on the hand-loom inquiry, &c.*

[CONTINUED FROM PAGE 317.]

*Wages in France and Physical condition of the Artisans.*

Monsieur Dupin has stated 2 fr. 26 cent. per day as the average payment in the northern, and 1 fr. 90 cent. as the average in the southern provinces. I believe this to be perfectly correct. There are numbers of trades wherein 1 fr. 50 cent. is the average rate of wages per day, but a far greater number earn 2 fr., which, taking France through, I believe to be as near an estimate as can be formed. They who subsist entirely on the profits of weaving plain goods, fall below 1 fr. 25 cent. or 1s. per day net wages, but these form a small and insignificant fraction of the working adults of the country.

I will give the rates of wages in the chief departments of manufacturing labour *seriatim* as I visited the districts. Alsace is the chief cotton district.

In Messrs. Schlumberguer's and Bocard's mills at Guebwillers, the wages were stated to me to be—

|           |                                           |
|-----------|-------------------------------------------|
| Spinners, | 2 to 3 fr. per day.                       |
| Women,    | 1 fr. 50 cent. to 2 fr. per day.          |
| Girls,    | 1 fr. per day.                            |
| Slubbers, | 1 fr. 40 cent. to 1 fr. 50 cent. per day. |



In the "Rapport," however, given in by these gentlemen in the year 1829, to a government commission of inquiry in France, I find the following different return:—

|           |                         |
|-----------|-------------------------|
| Men,      | 1 fr. 40 cent. to 2 fr. |
| Women,    | 1 fr. to 1 fr. 20 cent. |
| Children, | 40 cent. to 70 cent.    |

The increased aptitude of the workmen since 1829, may in some degree account for this discrepancy; but from other inquiries, I am convinced the former of these statements is the maximum, rather than the average rate of payment.

The hours of labour always exceed 13, and are often 14 of actual work, children as well as adults. There is no factory regulation law in France.

The wages of the hand-loom weavers are on the whole, the cost of living being taken into account, higher than in Scotland. In Normandy and in some few places in Alsace they are as low; everywhere else they are higher, or to speak more correctly, everywhere else have the hand-loom weavers of France a greater amount of the necessities and comforts of life.

I have shown that the reverse is the case with all other employments.

It is unnecessary to detail the wages of the hand-loom weavers, which vary for the most skilled class from 6 to 9 fr. per week; for the second rate class from 4 fr. 50 cent. to 6 fr.; and for women and children, forming the third or lowest class, from 2 fr. to 4 fr. 50 cent. These are net wages; the manufacturers either beaming the warps and furnishing the looms in factories, or paying equivalently. Something more, however, is generally earned in the factories; for the weavers prefer usually working at their own homes. The average net wages of an adult Alsace weaver will not exceed 5 francs; that is, a piece of calico of 70 porters, (French) 28 shots in a quarter of an inch, is paid about 5 fr. the cut of 25 French ells (of 44 inches); a good weaver will perhaps weave five ells per day, including lost time, or 6 francs gross wages.

The homes of the working classes are, for the most part, dirty, comfortless, and evincing every symptom of bad management and poverty combined. Even those who have children in the cotton mills, do not keep up any appearance of comfort. I am aware that, passing immediately from Switzerland, where the cottages are pictures of neatness and comfort, I was apt to be too unfavourably impressed with the very inferior condition of the Alsatian artisans. I shall, however, corroborate my own view of the matter, by a quotation from the opinion of one eminently qualified to form a judgment of the mental as well as bodily condition of those around him. In the mean time, I may remark, that I believe that the Alsatian weavers are, generally speaking, not without a sufficiency of food, though in all other respects they are certainly ill off. In the mountains of the Vosges, the peasantry are worse off still, and there looms are also found, but chiefly on the system of the "customer" weavers of Scotland, though not exclusively, for there are some who weave for manufacturers at very low wages.

On this subject, Mr. Nicholas Schlumberguer of Guebwiller, an eminent manufacturer, thus writes to me:—

"On the question which is engaging your attention, it may be said in general, that upon the whole the working class can live much more cheaply in France than in England, and consequently the rate of wages is lower in our country than in yours. It may also be said that the working classes are less given to the vice of drunkenness in France than in England; but they

are not moral for all that; their want of prudence is excessive; they live from hand to mouth (*du jour le jour*); the least illness, or want of work at all prolonged, plunges them into a state of profound misery. They feed themselves irregularly; their houses are dirty, which contributes to render their physical state worse than that of the English workmen.

"The moral and physical condition of the working class in general remains nearly stationary; there are made, here and there, efforts for its amelioration which have had happy results, but, up to this time, the opposition of the great majority of the manufacturers has prevented the Government from proposing to the chambers any regulations analogous to those which exist in England, on the age of admission of children in the factories, and in the duration of work."

At Lyons the long stagnation incidental to the American crisis, caused, since Dr. Bowring's visit, considerable distress; from the effects of which, the recent development of trade has but just relieved them. Neither have all the departments of Lyonese weaving yet resumed their former rates of wages. In the plain goods (*articles unis*), in which Zürich is very successfully competing with France, little is now done at all in Lyons. This description of goods has been carried (since Dr. Bowring's visit in 1834) almost entirely into the country, where, of course, food and lodging are to be had at much lower prices, and where, as the workmen are more scattered and less able to concert measures for keeping wages up, wages are more easily lowered. The necessity for lowering them, however, was apparent to me whilst at Zürich; and I was as much convinced by what I saw there, that Lyonese wages in plain silks must fall, as if I had already ascertained the fact.

The conflict which formerly existed between the *chefs d'atelier* (who are the owners of the workshops, containing from one to ten looms,) and their journeymen called *compagnons*, goes on in the country just as much as it formerly did in Lyons. In the town much greater harmony subsists as wages have for the most part risen. It is usual for the *chef d'atelier* to share the wages paid with the weaver or *compagnon* who weaves the web, the former supplying lodging and upholding the loom and defraying every contingent expense.

The following are examples of the changes in the rate of payment by the fabricant:—

|                                      | 1834. |       | 1838. |       |
|--------------------------------------|-------|-------|-------|-------|
|                                      | fr.   | cent. | fr.   | cent. |
| Common plain velvets, (per ell)      | 3     | 50    | 5     | 50    |
| Light plain satins,                  |       | 60    |       | 70    |
| Gros de Naples, fine quality, plain, |       | 70    |       | 90    |
| Do. light do.                        |       | 50    |       | 60    |
| Common figured silks,                |       | 80    | 1     | 00    |
| Rich do. do.                         | 1     | 00    | 1     | 50    |

There are among the figured silks for waistcoats, articles paid for as high as 5 and 6 fr. the ell. There is a new description of shawls, of which the ground is thick satin with velvet flowers, having the appearance of being embossed on it, of singular beauty and elaborate design, for which as much as 12 fr. per day gross wages are paid to the *chef d'ateliers*.

If a *chef* gained 2 fr. clear per day in 1834, he will gain at least 2 fr. 50 cent. now, and the *compagnon* must be an idle fellow if he earns less than 1 fr. 75 cent. Many earn upwards of 2 fr. per day.

It appeared also that a great moral improvement had taken place in Lyons, in consequence of the removal of some of the lower paid weavers to the country.

The independence of the weavers of Lyons is very great, and this is caused by the character of the industrial system pursued. The fabricant, of whom there are between 500 and 600 in Lyons, merely gives out the pattern and silk to the chef d'atelier, to whom is intrusted the entire task of producing the web through all the manifold difficulties of the complex operations incidental to the manufacture. The money paid is the object of separate barter, and is generally fixed at joint meetings of weavers and the fabricans. Continual disputes used to occur between them, which are now for the most part transferred to the chef d'ateliers and their compagnons, the latter having become extremely exorbitant in their demands. These form the least respectable class of weavers in Lyons. Having no fixed home they are a fluctuating population, and have neither the stability nor the activity of those who are intrusted with the responsibility, and to whom it imparts respectability. They sometimes, however, amass considerable savings, and occasionally, though not often, establish themselves as chef d'atelier.

In addition to the compagnons, or journeymen, there are also apprentices of both sexes to whom the master teaches his trade, either for a sum of money, or a period, during which the profits of the apprentice's labour belong to the master. When they are sufficiently practised in their art, the master gives the apprentices a task to perform, and whatever they do above is their own profit. If they fail in doing it, an indemnity is recoverable by the master.

With the high wages gained by the weavers, they are of course enabled to live well, and spend no inconsiderable sum on the aggregate in their Monday and Sunday recreations. The usual meals, and their cost, of a compagnon or common weaver, are thus accurately stated by Dr. Bowring:—"1½ lb. of bread, 30 cent., or 3d. (the pound being 18 ounces, and the best bread); one-fourth litre of wine, 12½ cent.; dinner, 25 cent.; cheese, 10 cent.; supper, 10 centimes." The dinner will consist generally of soup, and often of a bit of meat in it. Rent varies from L.3 to L.5 per annum, for two or three rooms. Many of the compagnons are boarded by their employers at about 5d. per day. Hours of work vary from 12 to 15.

In appearance, the weavers are an emaciated, miserable-looking set of beings. They are diseased and undersized. The parts of the dirty town of Lyons in which the weavers are principally located, are close and filthy, especially those lying between the Saone and the Mountains de St. Just and de Fourvières. Many individuals are often crowded together in a small apartment, one room frequently containing the man and his wife, two or three children, and a workman and his wife.

Lyons, however, is peculiarly exempt from epidemic disease, and was wholly free from cholera, though exactly in the line it took in 1832, and built, moreover, on the banks of two large rivers. I am persuaded that it owes this entirely to the large lime-kilns in the suburbs; the exhalation of which perceptibly impregnates the atmosphere; and I believe this to be a perfect preventive of cholera.

Tarare, near Lyons, is the chief muslin district of France, and the following extract from a letter, from an intelligent manufacturer, conveys the chief information I collected.

"A portion of our weavers in the country, gain only 75 cent. (7½d.) to 1 fr. 25 cent. (1s.) per day; those of the town, from 2 fr. to 2 fr. 50 cent.,



and sometimes 3 fr. according to their skill. The manufacturer furnishes only the reed and the upper mounting, all the rest being at the expense of the workmen. No deduction is made from the wages for the use of these articles.

"Those who are in the town weave all the year, those in the country, *at the outside, not above seven months in the year*; the remaining five months being occupied in agricultural employment. As nearly all the fathers of our weavers in the country are small proprietors themselves, the weavers are connected with the land, and are consequently not turbulent. Our industry, therefore, escaped the disasters, of which Lyons was the theatre in 1824 and 1832.

PHIL. LEUTNER, Père."

It appears to me, however, that the actual earnings of the weavers have not fallen in the same proportion as the rate of wages; except for the town weavers, it is, I need hardly remark, impossible to form any accurate estimate of their real condition, by the mere money-wages they receive; for the profits of agricultural occupation render their weaving wages merely an indefinite portion of their total income, which can only be estimated approximately.

It may be safely assumed, that a town weaver nets on the average 30 sous per day, and the country weaver 25, for 14 hours' work. They appear to me to work as hard as the Scottish weavers, though scarcely in the same manner: the latter will work desperately for three or four hours, in order that he may loiter and stand at his door an hour; the Tarare weaver, and the remark holds good elsewhere in France, keeps continually shuffling along, if I may so express it, and completes as much in 14 hours' sluggish work, as the Scottish weaver by broken portions of quicker work, extended over the same period.

The character of the Tarare weavers, is that of a quiet simple people, who have few wants, and but limited intelligence, in spite of the recent efforts of the priests to enlighten them.

In Normandy, the wages are very low among hand-loom weavers, who scarcely gain as much as those in the west of Scotland. They are the worst off in France, simply because they are rather more numerous in comparison with the demand for their labour. And the reason why they are so numerous, results from the easy sort of work done in that part of the country. Instead of muslins and silks, as at Tarare, Mulhousen, or Lyons, requiring skilled hands, and, therefore, limiting the number of those in the field of competition, Normandy produces pulicates, domestics, and other coarser articles. Consequently, I found the weavers there, *who had no means of other employment*, as badly off, or very nearly so, as in the west of Scotland, with which the goods produced by the Norman looms are in direct competition in third markets, whilst they nearly exclude us from their own.

At the same time, whilst the wages of Norman weavers are, if anything, lower than in Scotland, it must not be forgotten, that provisions are at least twenty per cent. cheaper, so that no great difference is perceptible in the condition of the two classes. And were I to be forced (putting love of country aside) to choose, whether I would be a pulicate weaver in Scotland or in Normandy, I think I should be sorely puzzled which to select; or rather which to consider the greater infliction.

The farmers here adopt the same custom towards the artisans as in Scotland, of allowing them land to set potatoes in, a custom very prevalent in Normandy.

The peasants live chiefly on vegetable soup, and the coarsest sort of bread.

The following are the ordinary wages earned in the Norman spinning mills, with which I was favoured by my friend M. Fauquet Lemaitre, one of the leading manufacturers of France:—

Spinners from 15 to 20 fr. per week, working from 80 to 84 hours. Women and girls, employed at the carding and drawing operations, gain from 7 to 10 fr. The power-loom weavers earn from 12 to 16 fr. per week.

Elbeuf is the largest cloth manufactory in France, and is rapidly increasing in the extent of its trade. The weavers here are in very easy circumstances. As there are no particular results from my inquiries at Elbeuf, beyond what are contained in the following letter to me, from the Maire of Elbeuf, who is also a very large manufacturer, and a most intelligent person, it will suffice to transcribe extracts from it.

“The working classes of our town of Elbeuf, enjoy, in general, easy circumstances; they have always lived happily for two very powerful reasons; the first, because our manufacturers are constantly in their workshops, work themselves with their workmen, know their wants, and identify themselves with all that happens to them, for good or evil: the second, because the price of weaving varies very little; the proportion between times of prosperity and times of distress, being 20 per cent. at most, in the amount of wages, and that only in certain departments.

“The work people are divided into three classes,—the adults, the day labourers, and the weavers.

“The adults receive a salary which varies according to their age, their strength, their intelligence, their age, from 75 cent. to 1 fr. 50 cent.; the largest number receive the average of 1 fr. 10 cent. I class as adults, young men from 12 to 18 years of age. Children from 9 to 12 gain 50 cent. to 75 cent. per day.

The day labourers taken at large from 18 years to 60, are paid from 1 fr. 50 cent. to 2 fr. per day, 1 fr. 75 cent. being the average. This class is but little intelligent.

“The weaver gains from 2 to 3 fr. per day; the ordinary average being 2 fr. 50 cent. The women receive from 75 cent. to 1 fr. per day. The young girls from 9 to 16 years old, earn from 50 to 80 cent. The day’s work begins at five in summer, and ends at eight in the evening; half an hour for breakfast, and an hour for dinner. In winter they work from 7 to 10 hours.

At St. Quentin, in the north of France, the working classes make no complaint; they seem all of them pretty well supplied with the necessaries and many of the comforts of life. They are all well clothed, and have plenty of vegetables to eat; little meat is consumed or desired by them. In the country it is a common practice, as in Normandy, for the farmers to give the use of land for setting potatoes; only in the neighbourhood of St. Quentin the farmers usually find both seed and manure, receiving half the produce as their share. This is an advantage to the labourer, or he would not avail himself of it, though I have heard it doubted.

I was at some pains to estimate the wages in the spinning factories of St. Quentin, and I found 7 fr. (5s. 10d.) rather above the average per head paid per week, taking men, women, and children collectively. In Lancashire it is 10s. 6d

The rates paid are as follows at St. Quentin:—

|                                                 | Fr. Cent. |    | Fr. Cent. |
|-------------------------------------------------|-----------|----|-----------|
| A spinner having under him at his own cost, two |           |    |           |
| piecers, earns per day,                         | 3 75      | to | 4 50      |
| A woman or girl,                                | 0 90      | to | 1 20      |
| The piecers (children),                         | 0 60      | to | 1 00      |
| Power-loom weaver having two looms,             | 2 50      |    |           |
| Dressers,                                       | 3 00      | to | 3 50      |

“The weavers in the country gain—Children, from 6 to 12 sous (3 to 6*d.*) per day. The women, from 14 to 20 sous (7 to 10*d.*) The men, from 30 to 60 sous (1*s.* 3*d.* to 2*s.* 6*d.*)

“The work people in the town, of all ages and sexes, work 13 hours by day. In the country the hours are not regulated, but they work nearly as much as in the town, especially in winter. Nearly the whole of the artisans are paid by the piece, whether weavers or cotton spinners.”

From my own investigations I am convinced that 30 sous (15*d.*) is rather above than below the average of the adult male weavers' earnings in the country.

Day labourers earn from 10 to 12 fr. per week. Mons. Lemaitre is further of opinion, that, though there is “very great distress” among the manufacturers and fabricans, there are very few of the working classes without employment. There is no question that the distress among the latter is confined to the weavers.

The price of food was as follows when I was at St. Quentin:—

*Bread* (white) 36 cent. per kilo., or 3½*d.* for 2½ lb. avoirdupois.

*Beef* (common sort) 55 cent., 5½*d.* per lb. of 18 oz.

*Veal and Mutton*, 65. cent. or 6½*d.* per lb. of 18 oz.

*Pork* about the same price.

Rent is high at St. Quentin. A small room and closet costs 11 fr. or 9*s.* 2*d.* per month without furniture. In the country 3 or 4 fr. per month.

Coal is about 2 fr. 20 cent. the hectolitre.

*Roubaix*, near Lille, is the most thriving manufacturing district of France.

The articles chiefly manufactured there are thibets, waistcoat pieces, and thick cotton goods.

There are about 12,000 looms in this district, of which half are jacquard looms. These latter are principally in factories; the manufacturers finding it necessary to preserve the privacy of their patterns.

The demand having increased so rapidly, wages have also risen. A weaver will, on the cotton goods, earn, on an average, 30 sous (15*d.*) per day; on the second class work, from 30 to 40 sous (15 to 20*d.*); and on the jacquard loom from 2 to 5 fr. per day, the average being about 3 fr.: these are gross wages. Net earnings will be weekly about 12 or 13 fr. for the jacquard weaver, and from 6 to 10 fr. for the plain weavers. Women and children obtain plenty of employment at the mills. Wages have risen by above one-third in the last few years.

Wages in most of the other departments of labour (not manufacturing) are for men, 2 to 3 fr. per day, and for women, 1 fr. 25 cent.

Thibets of woollen weft and warp, 11<sup>00</sup> 3 shots over, chains No. 22<sup>s</sup>, weft No. 38<sup>s</sup>. Wages 17 sols (8½*d.*) per ell of 44 inches, amounting to about 20 or 22 fr. on an average per week, out of which the weaver pays for winding, weft, and every thing but winding the chains. The earnings of



the weaver, therefore, on these goods could not be less than 2 fr. 50 cent., or 2s. per day, for 14 hours' work; and weavers have admitted as much to me.

I inspected a woollen spinning factory belonging to Mons. Delatre. The spinners were earning from 20 to 24 fr. per week, net, as a matter of course; and I was assured that the previous week one man had received for seven days' work, no less than 60 fr., out of which he had, however, to pay 19 fr. to his piecer; and it is by no means uncommon for them to earn 30 fr. net. The girls earned about 7 fr. 50 cent. per week, and the children 3 fr. per week.

I was assured that they worked 15 hours in this mill. If so, I can only say I never saw healthier looking people in any factory, except that of Mr. Edmund Ashworth's of Egerton. The rooms were all high, clean, well ventilated; and the machinery, though not of the newest description, extremely good.

There are several weaving villages in the north of France, but none of which exhibit any features in the rate of wages worthy of particular note.

At Tourcoing, for instance, the weavers gain about 9 or 10 fr. gross per week; these wages have been augmented by about a tenth during the last ten years.

The other working classes (adult males) gain from 1 fr. 75 cent. to 2 fr. 25 cent. per day.

The weavers are the most moral class in this town; they attend to the education of their children, and seem contented with their condition. The price of food was last year:

|        |                                    |            |                            |
|--------|------------------------------------|------------|----------------------------|
| Bread, | 32 cent.                           | (3½d.)     | per kilogramme (2½ lb.)    |
| Meat,  | 1 fr. 10 do.                       | do.        | do.                        |
| Coals, | 2 " 25 do.                         | (1s. 10d.) | per hectolitre of 22 gall. |
| Rent,  | average for weavers, 100 fr. (4l.) |            |                            |

At *Havre*, the average amount of wages of a male labourer is in the country, 2 fr. = 1s. 6d., in summer; and 1 fr. 50c. = 1s. 2d., in winter, without food; in towns, it is 2 fr. 50 c. = to 2s. a day, all the year.

A labourer's wife and four children, aged 14, 11, 8, and 5 years respectively (the eldest a boy,) earn in a year, 1000 fr. (40l.), provided the two eldest children are employed.

The rent of the labourers' habitations, from 50 to 100 fr. = 2 to 4l. a year.

In the south western provinces;

|                                                                                                                                                                          |   |   |                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|--------------------|
| The wages of an able-bodied male labourer, by the year, amount to                                                                                                        | . | . | 425 fr. = 17l. 0s. |
| A house and garden is found him, valued at 60 fr. per annum,                                                                                                             | . | . | 60      2    8     |
| In addition to the above sum, he receives four hogs-heads of piquette, (a beverage made by pouring water over the residue of the grapes and lees of new wine), valued at | . | . | 25 fr.             |
| Wood, for fuel, valued at                                                                                                                                                | . | . | 30                 |
|                                                                                                                                                                          |   |   | — 55      2    4   |

Total for the year, 540 fr. = 21l. 12s.

The wages of a day labourer are 1 fr. 50 c. (1s. 4½d.)

A labourer's wife and four children can earn, by labour, about 300 fr. (12*l.*) per annum, viz.

|                     |   |   |           |                          |
|---------------------|---|---|-----------|--------------------------|
| The wife,           | . | . | 120 fr. = | 4 <i>l.</i> 16 <i>s.</i> |
| Eldest boy,         | . | . | 80        | 3 4                      |
| Child 11 years old, | . | . | 50        | 2 0                      |
| Child 8 do.         | . | . | 30        | 1 4                      |
| Child 5 do.         | . | . | 20        | 0 16                     |

Total, 300 fr. = 12*l.* 0*s.*

Dr. Bowring, in 1834, collected the following returns, which I have revised:

| <i>In Paris—</i>                                                            |              | Fr. | Ct. |    | Fr. | Ct. |
|-----------------------------------------------------------------------------|--------------|-----|-----|----|-----|-----|
| Gunsmiths                                                                   | earn per day | 3   | 50  | to | 4   | 00  |
| Jewellers                                                                   | do.          | 3   | 50  | to | 4   | 50  |
| Toymen                                                                      | do.          | 3   | 00  |    |     |     |
| Capmakers                                                                   | do.          | 2   | 50  |    |     |     |
| Butchers—they are boarded, and may earn from 1000 to 1200 francs per annum. |              |     |     |    |     |     |
| Bakers                                                                      | earn per day | 4   | 00  | to | 4   | 50  |
| Brewers—they are boarded, and may earn 500 francs per annum.                |              |     |     |    |     |     |
| Hatters                                                                     | earn per day | 3   | 00  |    |     |     |
| Carpenters                                                                  | do.          | 3   | 00  | to | 3   | 50  |
| Cartwrights                                                                 | do.          | 3   | 00  |    |     |     |
| Shoemakers                                                                  | do.          | 3   | 00  |    |     |     |
| Carvers                                                                     | do.          | 4   | 00  |    |     |     |
| Nailers                                                                     | do.          | 3   | 00  | to | 4   | 00  |
| Ropemakers                                                                  | do.          | 3   | 00  |    |     |     |
| Cutlers                                                                     | do.          | 3   | 00  |    |     |     |
| Gilders                                                                     | do.          | 3   | 50  | to | 5   | 00  |
| Cabinetmakers                                                               | do.          | 3   | 50  | to | 5   | 00  |
| Tinmen                                                                      | do.          | 3   | 00  |    |     |     |
| Engravers                                                                   | do.          | 5   | 00  |    |     |     |
| Watchmakers                                                                 | do.          | 3   | 50  | to | 5   | 00  |
| Printers                                                                    | do.          | 4   | 00  | to | 7   | 00  |
|                                                                             | do.          | 2   | 50  | to | 3   | 50  |
| Masons                                                                      | do.          | 3   | 00  |    |     |     |
|                                                                             | do.          | 2   | 00  |    |     |     |
| Marble cutters                                                              | do.          | 4   | 00  |    |     |     |
| Joiners                                                                     | do.          | 3   | 00  | to | 3   | 50  |
| Goldsmiths                                                                  | do.          | 4   | 00  |    |     |     |
| Papermakers                                                                 | do.          | 3   | 50  | to | 4   | 50  |
| Perfumers                                                                   | do.          | 3   | 00  |    |     |     |
| Lacemen                                                                     | do.          | 4   | 00  |    |     |     |
| Pastrycooks—they are boarded, and earn from 600 to 900 francs per annum     |              |     |     |    |     |     |
| Paviors                                                                     | earn per day | 3   | 00  |    |     |     |
| Plumbers                                                                    | do.          | 3   | 00  | to | 3   | 50  |
| Plasterers                                                                  | do.          | 2   | 50  | to | 3   | 00  |
| Porcelain-makers                                                            | do.          | 3   | 00  |    |     |     |
| Soap-boilers                                                                | do.          | 2   | 50  |    |     |     |
| Saddlers and }<br>Coachmakers }                                             | do.          | 3   | 50  |    |     |     |

|                                                         |              | Fr. | Ct. |    | Fr. | Ct. |
|---------------------------------------------------------|--------------|-----|-----|----|-----|-----|
| Locksmiths                                              | earn per day | 3   | 00  | to | 3   | 50  |
|                                                         | do.          | 4   | 00  |    |     |     |
| Stonecutters                                            | do.          | 4   | 00  |    |     |     |
| Tailors                                                 | do.          | 4   | 00  |    |     |     |
|                                                         | do.          | 5   | 00  | to | 8   | 00  |
| Turners in wood                                         | do.          | 3   | 00  |    |     |     |
| Upholsterers                                            | do.          | 3   | 00  | to | 3   | 50  |
| Dyers                                                   | do.          | 3   | 00  | to | 5   | 00  |
| Tanners                                                 | do.          | 3   | 50  | to | 4   | 00  |
|                                                         | do.          | 6   | 00  | to | 15  | 00  |
| Terrace-makers                                          | do.          | 2   | 00  |    |     |     |
| Coopers                                                 | do.          | 3   | 00  |    |     |     |
| Do. They are also boarded, and get as wages 500 francs. |              |     |     |    |     |     |
| Turners in Metal                                        | earn per day | 4   | 00  |    |     |     |
| Blacksmiths                                             | do.          | 3   | 00  |    |     |     |

With regard to the food of these workmen, the terrace-makers and labourers live very economically, not expending more than from 16 to 17 sous per day: in the morning they repair to the low eating houses, called Gargotes, where for 7 sous they get soup, and a plate of meat with vegetables; their custom is to breakfast on the soup and vegetables, and carry the meat away with them for their dinner.

Thus, these 7 sous, two pounds of bread 8 sous, and perhaps for wine 2 sous, make 17 sous.

The masons, paviors, locksmiths, &c., do not exceed 20 or 21 sous; their only addition to the above being 4 or 5 sous for supper.

Carvers, gilders, saddlers, printers, &c., spend about 30 sous per day; viz. soup and meat for breakfast  $7\frac{1}{2}$  sous, dinner  $7\frac{1}{2}$  sous, wine at do. 6 sous, two pounds of bread 9 sous. The higher paid artisans spend at least 35 to 40 sous.

In the iron works at Vandelesse (Nievre), the price of labour is 1 fr. 70 c. per day; at Nevers, for manufacture of iron-cables, 2 fr.; at Fourchambault, 1 fr. 60 c. is the average rate; the workmen in the potteries at Nevers gain 1 fr. 75 c. per day; at Nogent, in the manufacture of linen goods, the wages are, to men 2 fr., women 1 fr. 25 c., and children 60 to 90 c. per day; at Mouy, in the woolen manufactures, men are paid from 1 fr. to 1 fr. 50 c., and boys of fifteen 1 fr. In the Department de l'Aube, the weavers of fine cloth get 1 fr. 75 c.; stocking-makers, 1 fr.; cotton spinners, 1 fr. 50 c. per day; reelers and winders, 1 fr.; tanners, 2 fr. to 2 fr. 10 c. At St. Etienne, the wages paid to the miners are, diggers, 3 fr. 50 c.; drawers, 3 fr. per day. At Rive de Gier, 4 fr. 25 c., and 3 fr. 50 c.; nailers receive either 7 to 10 c. per lb., or from 1 fr. to 1 fr. 50 c. per 1000. The tenders on silk worms are paid from 50 c. to 1 fr. per dry. Women employed in reeling silk receive 1 fr. per lb. At the forge of Janon (Vienne), a master founder is paid 8 fr., a founder 4 to 5 fr., a labourer 2 fr., and a boy from 1 fr. to 1 fr. 25 c. per day. At Rive de Gier, the labouring makers of coke receive from 2 fr. to 2 fr. 50 c. per day.

The "Ponts et Chaussées" pay their labourers 36 fr. per calendar month.

The food varies in different districts. Throughout the district called Landes (Heath), occupying about one-third of this department, the food consists in rye bread, soup made of millet, cakes made of Indian corn, now



and then some salt provision and vegetables, rarely, if ever, butcher meat; their drink water, which, for the most part, is stagnant.

In the other parts of Southern France, the peasantry live better. They eat wheaten bread, soup made with vegetables, and a little grease or lard twice a day, potatoes and other vegetables, but seldom butcher meat; their drink is wine or piquette; a family, composed as above, could lay something by from their gains at the end of the year, as the wants of the lower classes are much fewer than in England; in fact, the luxuries of tea, &c., are quite unknown.

I can corroborate most of these statements from my own observations.

*Wages in Switzerland, and Physical condition of the Artisan Peasantry.*

I am loth to speak of the wages of Switzerland. The pecuniary amount of wages is at all times a fallacious index to the real condition of the labourers. In Switzerland it is peculiarly so, owing to the very great subdivision of land, and the intermixture of agricultural and artisan occupations, a vast number of the working classes producing a portion of their own subsistence.

This and other peculiarities render the money wages of the Swiss artisans so inadequate a criterion of their eminently happy and prosperous condition, that I cannot too strongly caution my readers against making the former a measure of the latter. There is also another peculiarity in the supply of labour in certain branches of trade, common not only to Switzerland but to a large portion of Germany and Austria, which it is necessary to describe. I allude to the *Wander-schaft* system. By immemorial usage, no apprentice can obtain his freedom and become a master until he has spent so many years under his itinerant probation, and in following his avocation beyond his native country. He is furnished, on setting out, with a book, in which his various masters insert certificates of his service and conduct. This is called a "*Wanderbuch*." The journeyman is generally assisted not only by the trade to which he belongs, in towns where there is no employment for him, but by the donations of travellers. This part of the system I think objectionable, for it decidedly removes that abhorrence of dependence, which it is so essential to inculcate, as an element of physical, as well as of moral, welfare. I have been frequently asked by well dressed men, with a knapsack on their backs, for money on the road. However, from one of those who asked charity of me I derived a great deal of valuable information; he had been through Switzerland, part of Bavaria, and Wurtemberg, and was then on his way home to Baden. He spoke French admirably, and gave me an excellent account of the most salient features in the condition of the workmen in the different counties he had been in; and I need hardly say how greatly the experience they gain in their travels must tend to improve them in their trade, and, what is far more important, to add materially to their knowledge and mental capacity. I object, however, decidedly to the practice of begging, which cannot but remove the reluctance to so degrading a resource in after life when distress may arise, without the palliation which custom affords to the journeymen. In every other respect it appears advantageous; and in point of intelligence, I can speak from personal knowledge to the fact, that these journeymen on the Continent very far surpass the same class in this country in general education.

Mr. Kennedy of Felkirch favoured me with some written remarks on this interesting subject, which, from his long residence in Austria, no one more fully understands:—

"You are aware that here, as over almost every part of Germany, the trades of tailors, shoemakers, furriers, &c. &c., are carried on by masters who employ journeymen on the *Wander-schaft* as it is called, that is to say, workmen who go from town to town, stay a winter at one place, a summer at another, and receive generally, besides board and lodging, a certain sum weekly. This is usually about a dollar (3*s.*) to 3 florins (5*s.*); tailors 20 per cent. less. When they go from one town to another, it is a recognised privilege of theirs from time immemorial to ask assistance from passers-by as they travel along, and at the towns they pass through; and at every town there is a "*hepberge*," as they call it, where the master of the inn has agreed with the guild of that trade to lodge them at a very low rate; so that when they arrive, they immediately ask for the tailors' or shoemakers', &c., *herberge*, and by that means can travel very cheaply; a very bad system, which was originally intended to give them an opportunity of improving themselves in the knowledge of their art, but it is peculiarly favourable to vagabondising. At the moment I am writing this, a silk weaver has applied to me for assistance. From his passport I see he has been in Italy, and then in Hungary, and is returning to the Grand Duchy of Nassau, whence he came. Of course, in the large towns, they have the system of piece-work in a much greater degree."

In the linen districts of Berne, the weekly average wages (net) of the weavers were as follows:

|                                           |            |                           |
|-------------------------------------------|------------|---------------------------|
| 1. For the best damask (skilled workmen), | 10 fr.     | = 8 <i>s.</i> 4 <i>d.</i> |
| 2. For second class do.                   | 8 50 cent. | 7 1                       |
| 3. Plain webs,                            | 7          | 5 10                      |

The condition of the weavers is exceedingly good; they not only possess all the comforts of their class in life, but, excepting merely the cases where a large and young family has to be provided for, considerable savings are amassed by the Bernese linen weavers.

The price of food and lodging is so moderate in the neighbourhood of Langenthal, that an adult is able to support himself with ease on fivepence per day.

I confidently believe, that it would require 30*s.* per week in England, in the neighbourhood of any country town, to put a man, his wife, and three children (two of whom shall be above 15 years of age), in the same condition, and in all physical respects, on a footing with the average of Swiss artisan peasants having the same family. This statement requires a little explanation. I assume that an English family thus circumstanced, where provisions were of the average price in England, might be supposed to expend their 30*s.* somewhat thus:—

|                                                   |                         |
|---------------------------------------------------|-------------------------|
| Rent of cottage of 4 rooms, per week,             | 1 <i>s.</i> 6 <i>d.</i> |
| Bread, 26 lb. weight,                             | 5 0                     |
| Bacon, 8 lb. at 9 <i>d.</i>                       | 6 0                     |
| Coal, 2 cwt., or other fuel, year through,        | 2 6                     |
| Potatoes, or other vegetables, 1 bushel,          | 2 0                     |
| Beer, 14 quarts, 8 <i>d.</i> per gallon,          | 2 4                     |
| Tea or collée, 2 oz. at 5 <i>s.</i> ,             | 0 8                     |
| Sugar, 1½ lb. at 8 <i>d.</i> per lb.              | 1 0                     |
| Butter, 1½ lb. at 1 <i>s.</i> 2 <i>d.</i> per lb. | 1 9                     |
| Cheese, 1 lb.                                     | 0 9                     |
| Milk, 3 quarts,                                   | 0 6                     |

|                                                                  |   |   |   |      |     |
|------------------------------------------------------------------|---|---|---|------|-----|
| Soap, 1 lb.                                                      | : | . | . | 0s.  | 7d. |
| Candles, 1 lb.                                                   | . | . | . | 0    | 8   |
| Tobacco, 1 oz.                                                   | . | . | . | 0    | 3   |
| Man's clothing (one suit, 2 pair shoes and stockings, per year), | } |   |   | 1    | 6   |
| Woman's do. (two suits per year),                                | . | . | . | 1    | 0   |
| Three children (do. each per year),                              | . | . | . | 1    | 6   |
| Club,                                                            | . | . | . | 0    | 6   |
| Sundries                                                         | . | . | . | 0    | 6   |
|                                                                  |   |   |   | 30s. | 0d. |

Of course, the value of these articles will vary in different parts of England; but I believe the amount of comforts and necessities to be purchased for 30s. a week, will on the average, be found to tally with the above statement.

I fearlessly assert, that that amount of comforts and necessities, *mutatis mutandis*, is enjoyed by the bulk of Swiss artisan families in the German cantons of Switzerland. This is an assertion which cannot be set aside by mere *ipse dixit*. They who may desire to do so can alone ascertain its validity by personally visiting the homes of the Swiss peasants at different hours and in various cantons. I am not afraid to submit this statement to any one who has thus qualified himself to pronounce an opinion on the subject.

I am, moreover, impressed with a confident belief that the working classes of northern Switzerland, enjoy a greater amount of physical comfort, and of mental cultivation, than the working classes of any other European community.

Unmarried men and itinerant workmen are, for the most part, boarded in the houses of small proprietors.

The sums raised for the relief of the impotent poor are very trifling, and never, even where no institutions exist for their support, bear any comparison with poor-rates in England.

The price of food necessarily varies greatly in different cantons, as the transit-tolls, which constitute a great part of Swiss taxation, make provisions comparatively dear wherever they are not the produce of the canton in which they are consumed. The following will be found, however, a tolerably correct average for the majority of the German cantons.

Bread fluctuates from 1d. to 1½d. per lb. of 17 ounces: the average is 1½d. for common bread, *i. e.* one batz of Zürich. Meat varies from 2½d. to 4½d. per Swiss lb.; average price, 3d. Potatoes, 20d. per sack of 33 gallons; but the fluctuations are very great. Milk, from 5 to 7 farthings per pot of 3 pints. Wine, for workmen, 3s 4d. per quart. Wood also varies much, from 20s. to 30s. per cord of 90 feet.

The meals of the Swiss consist more of porridge than is general in England; and much more milk and cheese are consumed. In other respects (wine and cider being substituted for beer), the catalogue of articles I have given above will scarcely differ in the two countries. The amount of meat I have purposely stated rather low.

Wages were higher, as in England, during the war; for persons knowing how to weave were then smaller than they now are in proportion to the demand for woven goods. The peace returned a number of soldiers to the country, and weaving very soon resumed its rank among the lowest of arts.

The high education of the Swiss soon taught them to perceive that a handi-



craft, at least as far as plain weaving is concerned, requiring the skill of children and the strength of women, must necessarily be remunerated by the wages of children's and women's labour. Weaving, therefore, except in the fancy work, has long ceased to be a separate employment; and exists but as the occupation of children, women, and elderly men, or as occupying the intervals of higher branches of adult industry.

A very important effect results to the economy of wealth from this system. It appears that, by this junction of manufacturing and agricultural industry by the same persons, an augmentation must accrue to the production, and consequently to the wealth, of the country. An agriculturist in England seldom works after four o'clock in the afternoon: the Swiss agriculturist, on the contrary, occupies himself at the loom not only in the evening, but during bad weather, and in winter, when the English farm-labourer is idle. The loom, which is here an exclusive and starving occupation, is there a pastime of supplementary production. It is, I think, manifest that the Swiss system increases the wealth of the nation; but it must be remarked, on the other hand, that were the sort of out-door labour performed by the Swiss artisans the same as that of the English labourers on arable farms, instead of being chiefly horticultural and pastoral as in Switzerland, it is questionable whether the hands inured to the plough, the flail, and the pitchfork, would be fitted for the weaving of muslins and gingham for evening amusement.

TO BE CONTINUED.

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*On Beet Sugar.* By J. C. BOOTH.

There are few subjects which have created more sensation in the greater part of Europe, and the United States, simultaneously, than the manufacture of sugar from beet root. That it should have induced many individuals in this country to experiment, with a view to its manufacture, the characteristic enterprise and ingenuity of our people might guarantee, but may we not assign as the chief reason of their failure, or only partial success, the fact, that too many of us still boast of our practical knowledge, with a sidelong sneer at the assistance of science. It is rather more surprising, to observe the intense and all pervading interest manifested on various parts of the continent of Europe, especially in Germany, on the sugar-beet and its important product, as it clearly shows that this learned people has received an impulse with the rest of the world, relative to more modern manufactures, or rather that the zeal with which scientific men have devoted themselves to the advancement of the arts, is now developing its effects on the mass of the community. The frequent questions asked relative to the making of beet-sugar, may be better answered by a concise description of the superior method of extracting sugar from the dried beet, the main part of the account, being taken from Dingler's Polytechnic Journal, for 1838, Bd. LXIX. The drawings in all their details will be omitted, and merely the general features of the process described.

1. *Cleansing.* They must be washed, to free them from the soil which adheres to them, and this may be executed in a simple tub, or on a larger scale, a vat, into which water flows. A convenient arrangement for this purpose, might be a net-work cylinder, slightly declining from a horizontal position, revolving under water, or through which water should abundantly flow. The beets coming out from the depressed end of the cylinder, will be perfectly clean.

2. *Cutting.* They are next cut by a machine into long strips, exhibiting a square by a cross section, i. e. into long parallelopipeds, which is ac-

complished by a series of small knives attached to a sheet of iron, parallel to, and at short distances from, each other, which first make incisions as deep as the required thickness of the pieces, and are followed by a long knife, behind and at right angles to the smaller ones, by which the strips are separated." The knife with the smaller ones, cut by a vertical motion, but there might be a greater economy of time, by bringing a series of these cutters on a wheel, and attaching the smaller knives to the large one, suffering them to project a little below it, so that their incisions may be immediately followed by the edge of the long knife.

3. *Drying.* "Various and simple arrangements have been devised, for drying the pieces thus cut, in all of which, the principle consists in exposing them in thin layers, to a current of air, heated to a temperature of between 100° and 145° Fahr.; for if below 100°, they are apt to ferment, and if above 145°, they are liable to decomposition. For this purpose they are placed on wire nets, in the form of drawers, to the depth of one or two inches, the drawers sliding in one over another, at the distance of three inches, to allow of a free circulation of air. The drying chamber, or house, is heated, either by a hot-air furnace, or by steam tubes. A better arrangement, however, and one requiring but little hand-labor, is a series of endless wire-nets, one over the other, and each passing around a roller at each end. The pieces are carried from the cutting machine, on an endless cloth, up the highest of the nets, on which they fall, and are carried to the farthest end, by its constant motion, where they fall on the next lower endless net, which at this end projects beyond the uppermost, moving in the opposite direction on to the farther end of the second, which does not reach as far as the third, they are received on the latter, and again transported to its farther end, and thus by moving alternately in opposite directions, on the adjoining nets, they reach the lowest, from which they are thrown off in a dried, or sufficiently dried, state for use. These parallel nets are all in a chamber, heated by steam tubes from below; lower openings in the apartment, admitting cold and dry air, the upper ones above the nets, permitting the egress of the hot air surcharged with vapor. After drying they are ground to powder."

4. *Sugar extraction.* "The saccharine matter may be extracted by pure water, but it is found to be more advantageous to add acid, or lime, to it. The former is preferable, and sulphuric acid the most convenient. To nine parts of water add two-thirds or three-fourths of a pr. ct. of sulphuric acid, (according to the amount of sugar in the beets,) and stir in four, or even more, parts of the powdered beet. The stirring should be continued until the acidulated water is absorbed, when the mass is subjected to pressure in bags; the remaining mass is again treated with the same quantity of equally acid water, and pressed, but the liquid thus obtained, is used for the next fresh quantity of powder. The moistening and pressing are continued until all the sugar is extracted.

The portion first pressed out, is treated with a quantity of slaked lime a little more than sufficient to neutralize the acid, and the precipitation of sulphate of lime, takes place fully at the temperature of 165° to 190°. Fahr. The clear liquid is drawn off and crystalized by the ordinary sugar-refining process."

5. *Theory.* Beside sugar, there are many other vegetable principles contained in the beet, of which gluten and albumen are most injurious and difficult of management, but by drying they are rendered insoluble, and cease to be troublesome. It is also in consequence of the same operation, that less animal charcoal is required for purifying the sirop, than where the beets were

not dried. Sulphuric acid renders more insoluble the gummy matter, and probably decomposes a combination of a portion of the sugar, but as there are other acids also present, a little more lime is added to neutralize them, than is sufficient for saturating the sulphuric acid. The beet may contain from six to twelve pr. ct. of sugar, but much of it is lost in the process of manufacture. It is similar to that obtained from the sugar-cane, and is hence called cane-sugar, to distinguish it from other varieties, as raisin or starch-sugar, sugar of milk, &c.

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*On Raisin Sugar.* BY J. C. BOOTH.

When raisins have been exposed to the air for a length of time, small crystalline grains will be found upon and within them, which have a sweet taste and are a species of sugar. The same kind may be made by the action of diastase, or sulphuric acid, on starch, and indeed starch-sugar, or rather starch-sirop is much used in parts of France and Germany. The process of manufacture is as follows:

1. *Conversion of the starch.* One thousand parts of water are brought to the boiling point, in an open vessel of copper or lead, and fifteen parts of sulphuric acid added, previously diluted with thirty parts of water. When the fluids are well mingled, a cover is put on the vessel with a small opening in its centre through which the starch is introduced. Four hundred and fifty to five hundred parts of dry starch, (or as much wet as contains this quantity,) are put into the opening, in the cover of the vessel, in very small portions at a time, so that the fluid may continue boiling and not become thick. A few minutes after the last portion is added, the fire is extinguished, and chalk is thrown in to neutralize the acid. The clear liquor is drawn off, when the sulphate of lime has deposited and filtered through ordinary sugar filters. It is then evaporated to one half its volume, twenty-five parts of animal charcoal stirred in with a little blood, boiled and filtered through Taylor's filtering apparatus. This is starch-sirop, from which sugar may be obtained, by evaporating to 40—45° Baumé and cooling. It forms a white, coarsely granular mass, from which the molasses may be separated in the ordinary manner. One hundred parts of dry starch, give one hundred and fifty parts of syrup, or about one hundred of dry sugar.

2. *The Theory of the process.* The conversion of starch into sugar, by this process, is one of the most singular operations of chemistry, and has given rise to a new doctrine in the science. We perceive that by the operation on a large scale, they obtain an amount of sugar equal to that of the starch, but De Saussure obtained in a careful experiment, from one hundred of starch, one hundred and eleven of dry sugar. The sulphuric acid is unchanged, for there is the same amount remaining after the operation that was originally introduced; nothing is absorbed from the air, nor is there any evolution of gas, for the operation may be conducted equally well in closed, or in open vessels. The starch alone has changed, and this change is effected by its taking up a certain quantity of water, or rather the elements of water, hydrogen and oxygen. According to Saussure, one atom of starch takes up about two atoms of water. It appears then that the presence of sulphuric acid is sufficient to produce such an alteration among the elements of starch, that a new and different product results. For this reason and from many analogous facts, the French chemists give to this singular method of decomposition, the name of *presence*; Berzelius calls it *catalysis*, which signifies a decomposition, by the interchange of the elements of a



body among each other. The catalytic influence of sulphuric acid then, is to convert starch into sugar, where water is present. All other acids will produce the same result, and the same kind of sugar may be obtained in a similar manner, from other organic substances, such as linen, cotton, wood, &c. But the change is not immediate, for it is observed to convert the starch first into gum, and the gum into sugar. It is, however, not the mineral acids alone, that produce this effect, for an organic substance has been discovered in malt, which possesses the same power in a higher degree. This is diastase, which converts starch into gum, (or dextrine,) at a temperature of  $150^{\circ}$  to  $160^{\circ}$ , while the mineral acids require  $185^{\circ}$  to  $205^{\circ}$ . One part of diastase will change two thousand parts of starch into dextrine, and at least one thousand parts into sugar. Through the presence of diastase, therefore, or more properly by its catalytic influence, starch of wheat, potato, &c., is first changed into dextrine, and then into sugar; a highly interesting fact, as giving us a clearer view of the formation of gum and sugar in plants, and of the processes for manufacturing alcoholic liquids, which require the presence or formation of sugar, prior to their vinous fermentation.

In concluding the above articles on the manufacture of two varieties of sugar, the following table of the amount of sugar consumed in Europe, in 1836, may not be uninteresting. It is extracted from Dingler's Polyt. Jour. lxxvii. p. 319.

| Kingdoms of Europe.              | No. of millions of |                    | lbs. for one    |
|----------------------------------|--------------------|--------------------|-----------------|
|                                  | Inhabitants.       | Su gar lb.         |                 |
| England, . . . . .               | 16 $\frac{1}{4}$   | 321 $\frac{1}{2}$  | 20              |
| Ireland, . . . . .               | 8                  | 32                 | 4               |
| France, . . . . .                | 33                 | 178 $\frac{1}{2}$  | 5 $\frac{1}{3}$ |
| Prussia, . . . . .               | 14                 | 56                 | 5               |
| Bavaria, . . . . .               | 4                  | 10                 | 2 $\frac{1}{2}$ |
| Switzerland, . . . . .           | 2                  | 12                 | 6               |
| Belgium, . . . . .               | 4                  | 60                 | 15              |
| Holland, . . . . .               | 2 $\frac{1}{2}$    | 35                 | 14              |
| Denmark, . . . . .               | 2                  | 10                 | 5               |
| Sweden and Norway, . . . . .     | 4                  | 12                 | 3               |
| Spain, . . . . .                 | 14                 | 87                 | 6 $\frac{1}{4}$ |
| Portugal, . . . . .              | 3 $\frac{1}{2}$    | 16 $\frac{1}{2}$   | 5               |
| Smaller German states, . . . . . | 8                  | 40                 | 5               |
| Italy, . . . . .                 | 18                 | 36                 | 2               |
| Austria in the commercial union, | 19                 | 40                 | 2               |
| “ without “ “ . . . . .          | 15                 | 25                 | 1 $\frac{2}{3}$ |
| Russia, . . . . .                | 40                 | 40                 | 1               |
|                                  | 207 $\frac{1}{4}$  | 1011 $\frac{1}{2}$ |                 |

#### Copal Varnish.

The following method of preparing a copal-varnish, is not novel, but its simplicity and the superior quality of the product, may render it acceptable to many of the readers of the Journal.

Enclose coarsely-powdered copal in a linen rag, and hang it in the neck of a flask, or bottle, to such a depth that it cannot touch the spirits of wine, which is in the bottom of the vessel. Tie a piece of bladder over the

mouth of the flask, and make a few perforations with a pin, for the escape of a little alcoholic vapor. If the vessel be placed in a warm situation, thick and viscid drops of the copal, combined with alcohol, will slowly fall into the liquid below, and gradually dissolve, until the whole of the copal is extracted. When dissolved, the clear liquor may be decanted from a very small quantity of sediment, and it will prove a more transparent and beautiful varnish, than can be procured by any other method. The same process is applicable to other difficultly soluble resins, and will be found useful where rapidity is not required. B.

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*Soda-Manufacture in Hungary.*

Native carbonate of soda is found in greatest abundance in Little Cumania, particularly near Shegedin; it likewise occurs in many other places, in greater or smaller quantity. It effloresces, out of the moist earth, forming a white crust, and in the spring of the year, before sunrise, it appears like an extensive covering of snow. With greater care than they now employ, the workmen might readily gather it sufficiently pure for ordinary technical purposes by raking. The whole of the surface is gathered, and sold to the soda manufacturers, who distinguish its quality and richness, by the taste. It is leached in square vats, until the remainder ceases to have a saline taste. The fluid is dark brown, and beside carbonate of soda, contains much sulphate and muriate of soda, humic acid, and other mechanical impurities. It is boiled down in a large sheet-iron pan, to a siropy consistence, transferred to an adjoining pan, and evaporated to dryness under constant stirring. The mass is of a dirty yellow, or brown, with white and black spots. It is gradually heated in a calcining furnace with the access of air, until vapors cease passing off, then fused at a higher temperature and taken out, when partially cooled. A large portion is employed in the country itself, in the manufacture of soap, the remainder sold as raw calcined soda, as there is no manufactory for crystalizing it. If the demand for it were increased, the production of this salt might be increased to three or four times the present amount, as the country contains numerous soda lakes. Beside Trieste, from which some of the productions of Hungary, find their way to the American market, there is a port on the Adriatic, belonging exclusively to that kingdom, whence we might obtain, at lower rates, the products of one of the most fertile countries of Europe.

Selected from Erdmann's Journal, für praktische Chemie, Bd. xiii.

B.

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*On Galls used in the manufacture of Black Ink.*

Blue aleppo galls are employed in great quantity, in the manufacture of black ink, in consequence of the large amount of tannin they contain, nearly all of which, by a judicious management, is converted into gallic acid. Being greatly superior to oak bark in their content of tannin, they might be substituted for it, in the process of tanning leather, were not their high price a serious impediment. They are excrescences on the leaf-stem of the quercus infectoria, growing in the Levant, and are produced by the incision of the female gall-wasp. There is, however, another kind of galls, the acorn of the Quercus cerris, which receives a malformation from the incision of an insect, and produces a substance not unlike the aleppo galls, but much more irregular and with bold projecting points. They are found abundantly in Hungary, and the Southern provinces of Austria, where they are employed in dyeing and tanning, particularly in the latter art. They

are known under the name of Knoppern, in Germany, and Galles à l'épine, in France, and in the former country, are considered but little inferior to good aleppo-galls. A manufactory has been established at Vienna, for obtaining a solid extract from them, which has been successfully employed, in dyeing dark colors, and in tanning. Either the knoppern, or their extract, might be obtained at Trieste, and might prove a useful substitute for ordinary galls, whether in dyeing, or in the manufacture of ink. J. C. B.

## FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Assay of Gold.*

In the last number of the Journal, a new method of assaying gold, proposed by Lewis Thompson, Esq., is extracted from the London and Edinburgh Philosophical Magazine. It consists in adding to the gold assay-piece, an excess of silver, and then fusing the mass down with the chlorides of silver and of sodium, to remove the base metals. The silver is afterwards separated by nitric acid. "By this plan," says the author, "the tedious process of cupellation is avoided."

It may not be unimportant, to some of the readers of the Journal, to be informed, that Mr. Thompson's plan differs from the usual one by cupellation, only in two particulars, in both of which the old process has manifestly the advantage. In this process, lead alone is employed to remove the base metals, instead of the two chlorides, and it is simpler, perfectly effectual, and not subject to decrepitation. The second point of difference, is that a cupel, composed of bone ashes, is used instead of a crucible; and this cupel possesses the invaluable property of absorbing the oxides of lead, and of the baser metals, and leaving a clean button, composed only of gold and silver. In the new process, this advantage is not presented, and there will be grains to be separated from the crucible, as after the operation of fluxing;—thus adding not only to the labor of the process, but to the uncertainty of the result. We are, therefore, led to the conclusion, that the process proposed by Mr. Thompson, is more complicated, more inaccurate, and even more "tedious," than that now in universal use. U. S. M.

*Postscript.*

Some time after the above article was communicated, an opportunity was taken of making trial of Mr. Thompson's method of assay, and the results render it proper to modify, in some degree, the above remarks. The gold, the fine silver, and the chloride of silver, were melted together in a small crucible, and the button of gold and silver formed was found to be much more perfect and better insulated than had been expected. Five assays were made, and the results, by the old and the new process, expressed in thousandths, were as follows:

| No.    | by cupellation, |       | by Thompson's process, |       |
|--------|-----------------|-------|------------------------|-------|
| No. 1, |                 | 968   |                        | 968.5 |
| 2,     | "               | 890   | "                      | 889.  |
| 3,     | "               | 936.5 | "                      | 936.7 |
| 4,     | "               | 900   | "                      | 900.2 |
| 5,     | "               | 460   | "                      | 460.5 |

This comparison of the two methods is certainly very satisfactory, the greatest difference being but one thousandth.

In employing Mr. Thompson's process, an evil was observed which had not been anticipated. It is, that a sensible portion of the chloride of silver is volatilized during the fusion, and consequently lost. To show this, the fol-



lowing statements of the first and last assays—being of the finest and basest specimens, are presented. The weight 1000 is equal to between 7 and 8 grains.

|                                          |                          |
|------------------------------------------|--------------------------|
| No. 1, Gold, with silver,                | 1000: no copper          |
| Fine silver,                             | 2000                     |
| Chloride of silver,                      | 2700 = 2037 fine silver. |
|                                          | <hr/>                    |
| Button of gold and silver after melting, | 5037                     |
|                                          | <hr/>                    |
| Loss of silver by the process,           | 3088                     |
|                                          | <hr/>                    |
|                                          | = 1949                   |
| No. 5, Gold, with silver,                | 494 + copper 506         |
| Fine silver,                             | 1400                     |
| Chloride of silver,                      | 3000 = 2260 fine silver. |
|                                          | <hr/>                    |
| Button after melting,                    | 4154                     |
|                                          | <hr/>                    |
| Loss of silver,                          | 2580                     |
|                                          | <hr/>                    |
|                                          | 1574                     |

On the whole, though the new process is certainly not so good as that by the cupel, and is not likely ever to replace it where numerous assays are to be made, as at a mint, yet it is certainly better than was supposed when the above remarks were made, and it has the advantage, which is valuable under many circumstances, of not requiring a muffle furnace, or a cupel of bone ashes.

U. S. M.

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Description of an improved Faucet, for drawing thick and drying liquids.*

Sir,—I send you a description of a Varnish Faucet, particularly adapted to drawing thick, and drying liquids, such as varnishes, oils, molasses, &c.; to prevent its being patented by some future inventor, and that it may be made public, if it should be thought worthy.

All common kinds of cocks, or instruments for drawing liquids, have an interior surface below the closure, or place where the liquid is shut off, which is exposed to the air, and which receiving a fresh coat at every draught, when used for varnish, soon gets filled up, and the instrument is thus rendered useless, unless it can be cleaned out. To obviate this difficulty, and several others, I contrived the instrument, now to be described, which I have had in use for several years, and found to answer admirably well.

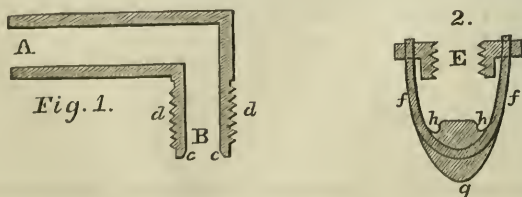


Fig. 1 represents a section of the tube, which may be made of any suitable metal, or composition. (As we have no brass foundry here, I had one turned out of cast iron.) A, is the end which is soldered into the canister.

At the orifice, at B, is turned a small bevel, as shewn at c, c. On the outside of the pendent part, is cut a coarse threaded, or double threaded screw, d, d, on which fits the nut E, (fig. 2,) having a rim, or flanch on the upper part, in which two holes are drilled opposite each other, to receive the ends of the bent wire, f, f, riveted fast there. A conical, or proper shaped, hole is made in a piece of wood, the bend of the wire inserted, and the hole filled with tinner's solder, to form the stopper. This is to be rasped into its proper shape by giving it as little surface as possible, leaving it long enough, so that the liquid which is to run over it, will follow it down, and run off at the blunt point, g. The annular bevel h, h, is to be fitted accurately to the bevel c, c, by trials. By screwing the surfaces tightly together, a small impression is left on the tin and lead, which will indicate where it is further to be cut away. When the impression is continuous round the whole beveled ring, it will then close perfectly tight. There will generally be play enough in the screw, to admit a more perfect indentation on the bevel of the stopper, being made by a hammer, by placing the point g, on soft wood, and striking on the tube above. The nut is turned by placing the thumb and finger on the rim, the circumference of which, may be scalloped.

The disadvantages of this instrument, in comparison with others, are, that it costs more, that the point must necessarily extend downwards, more than convenient, and that in drawing thin fluids it will scatter. This may be obviated, by attaching a tin funnel-shaped hood to the nut.

Its advantages are, that it is strong, easily worked, and not liable to get out of order; that it can, at once, and with the greatest ease, be shut perfectly tight, even under the greatest head, or pressure, that can possibly be put upon it, as the fitting surfaces are quite small, (the ring presenting the least possible amount of surface, which must be brought into contact, to close the same, or an equal section of aperture,) and are brought directly together, by a screw power. Lastly, there is no internal surface exposed to the air, to be clogged up. Concretions on the stopper, can at any time be scraped off, and if suffered to remain, cannot stop the faucet from operating.

Yours,

AMASA D. SPROAT,

Druggist, Chillicothe.

Chillicothe, Ohio, May 28th, 1840.

## Civil Engineering.

*General Demonstration of the Prismoidal Formula, used in Excavation, Embankment, and Masonry calculations.* By ELLWOOD MORRIS, Civil Engineer.

In the number of this Journal, for January, 1840, the writer endeavored to develop a mode of measuring excavation and embankment solids, which upon the general *Hypothesis that the surface of all ground is composed of planes, longitudinally and transversely, and free from twisted surfaces*, may be regarded practically as accurate.

This method was made to depend essentially upon two points.

1st. That the formula, expressing the capacity of a prismoid, is the *fundamental rule*, for the mensuration of all right lined solids, whose terminations lie in parallel planes, and is equally applicable to each.

2nd. That any solid, whatever, bounded by *planes*, and parallel ends, may be regarded as composed of some combination of prisms, prismoids,

pyramids, and wedges, or their frustra, having a *common altitude*, and hence capable of computation by the general rule alluded to.

From these premises, the inference was drawn, that any such solid, (the middle section of which, parallel to the ends, could be ascertained,) was susceptible of accurate determination: and consequently as the mid section of any given portion of excavation or embankment, can be correctly deduced from the data, usually taken in the field, that therefore the capacity of these solid portions might be thus calculated. And we may here observe, that the same method is evidently applicable to masonry calculations, with even greater facility, as structures of masonry are usually composed of symmetrical solids.

The remarkable property of the prismoid, above alluded to, was established in connexion with prisms, pyramids, wedges, and frustra, of pyramids, by a simple inverse algebraic process, displaying the relation between the common rules, laid down by the writers on mensuration, and the prismoidal formula. But this formula, admits of a direct demonstration by the aid of the integral calculus, and of a more connected proof that it is the *fundamental rule* for the solidity of all right lined solids terminating in parallel planes.

As the paper on mensuration, before alluded to, relies upon the establishment of this property, it has occurred to the writer that it might be agreeable to some of the readers of this work, to have a direct development of the principles, which that essay reduces to practice; and with this view, I propose, first, to establish the truth of the prismoidal formula, and then to trace up the dependence upon it, of the ordinary rule for the mensuration of other solids.

*General Demonstration of the Prismoidal Formula.*

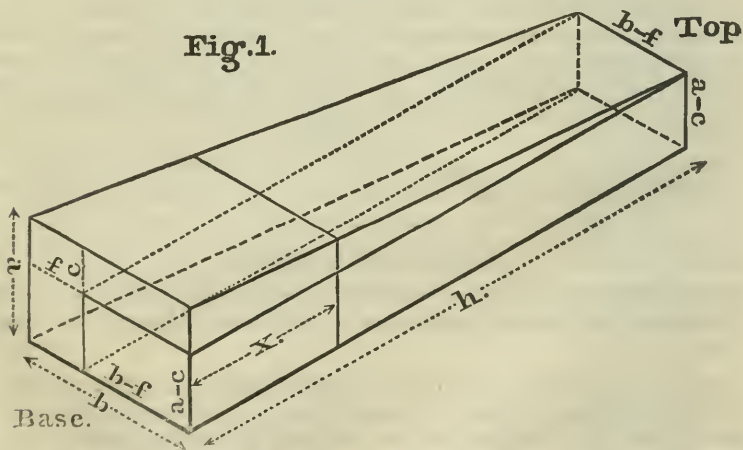


Fig. 2. Base =  $b$ .

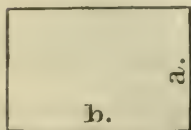


Fig. 3. Mid. Sec. =  $m$ .

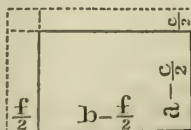
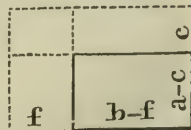


Fig. 4. Top =  $t$ .



Let fig. 1 represent a prismoid; fig. 2. the base; fig. 3 the mid section; and



fig. 4 the top. All the dimensions being designated, as marked upon the several figures.

The area of the base will be, (see fig. 2.)

$$a \times b = ab.$$

The area of the mid section will be, (see fig. 3.)

$$\begin{aligned} & \left(b - \frac{f}{2}\right) \times \left(a - \frac{c}{2}\right) \\ &= \left(\frac{2b - f}{2}\right) \times \left(\frac{2a - c}{2}\right) \\ &= \frac{4ab - 2af - 2bc + fc}{4} \end{aligned}$$

Whence four times the mid section:

$$= 4ab - 2af - 2bc + fc.$$

The area of top will be, (see fig. 4.)

$$\begin{aligned} & (b - f) \times (a - c.) \\ &= ab - af - bc + fc. \end{aligned}$$

Any transverse section of this prismoid, parallel to its base, or top, will be a rectangle.

The lengths of the sides forming the rectangle of the top, are supposed to be less than those of the base, which correspond to them by the quantities  $f$  and  $c$ , respectively. And it is evident from inspection, that the sides of the rectangular sections, proceeding from the base towards the top, *diminish* as the distance of the section from the base *increases*.

Let  $x$ , be the distance of any section from the base, supposing it, of course, to be parallel to the base or top, then the diminutions in the sides of this rectangle, will be to the total diminutions in the ratio of  $x$  to  $h$ , or as  $\frac{x}{h}$ .

Therefore, generally, the area of any rectangular section of a prismoid, at any distance,  $x$  from the base, will be

$$\begin{aligned} &= \left(a - c \frac{x}{h}\right) \times \left(b - f \frac{x}{h}\right) \\ &= \left(\frac{ah - cx}{h}\right) \times \left(\frac{bh - fx}{h}\right) \end{aligned}$$

$$\text{Whence expanding} = \left(\frac{abh^2 - bchx - afh x + fc x^2}{h^2}\right) = \text{Area section.}$$

Wherefore the element of solidity, or differential of the solid,

$$= \left(\frac{abh^2 - bchx - afh x + fc x^2}{h^2}\right) dx$$

$$\text{Whence } \frac{abh^2 dx}{h^2} - \frac{bchx dx}{h^2} - \frac{afh x dx}{h^2} + \frac{fc x^2 dx}{h^2}$$

The integral of which will represent the capacity of any frustrum of a prismoid, whose length =  $x$ .

$$\int \frac{abh^2 dx}{h^2} - \int \frac{bchx dx}{h^2} - \int \frac{afh x dx}{h^2} + \int \frac{fc x^2 dx}{h^2}$$

$$= \frac{abh^2x}{h^2} - \frac{bchx^2}{2h^2} - \frac{afhx^2}{2h^2} + \frac{fcx^3}{3h^2}$$

In point of fact, this integration produces a constant quantity, C, but as this = 0, when we estimate the capacity of the solid, from the base, as we propose to do, we may neglect it.

Reducing to a common denominator, we have,  $\left\{ \frac{6abh^2x}{6h^2} - \frac{3bchx^2}{6h^2} - \frac{3afhx^2}{6h^2} + \frac{2fcx^3}{6h^2} \right\}$

which is the general expression for the solidity of any frustrum of a prismoid, whose length measured from the base =  $x$ . Now to transform this expression, so as to apply to a whole prismoid, we must suppose  $x = h$ , and let  $s$  = solidity:

Then substituting  $h$  for  $x$  in the above expression we have,  $\left\{ \frac{6abh^3 - 3bch^3 - 3afh^3 + 2fch^3}{6h^2} \right\}$

$$\text{Or dividing by } h^2 = (6ab - 3bc - 3af + 2fc) \times \frac{h}{6} = S.$$

Which expression may be transformed into the following,

$$\left( (ab - bc - af + fc) + (4ab - 2bc - 2af + fc) + (ab) \right) \times \frac{1}{6} h = S. (A.)$$

We will call this equation A, and it is equivalent to

$$\left( (\text{Area of top.}) + (\text{four times area mid. sec.}) + (\text{Area of base}) \right) \times \frac{1}{6} h = S.$$

See the areas of these sections as heretofore deduced. The above equation A, is in fact, the general formula.

$$(b + 4m + t) \times \frac{1}{6} h = S.$$

at which we desired to arrive, and the truth of which is established by the foregoing investigation.

To trace up now the dependence of the usual rules for the capacity of certain solids, upon the general formula, it may be premised, that of all right lined solids, bounded laterally by longitudinal planes, and terminated in two transverse parallel planes, we distinguish but *four* independent species, viz:

1. Prisms, which, on account of the analogy subsisting between them, include cylinders.

2. Pyramids, which include cones, because cones, and pyramids of a common altitude, and equal bases, are equal.

3. Wedges.

4. Frustra of pyramids, which by analogy include frustra of cones.

To show that the general formula, is the *fundamental rule* for determining the solidity of these several solids, and by a necessary consequence, for the mensuration of any right lined solid whatever, made up of any combination of the four species, having a *common altitude*. We will take up,

#### 1. Prisms.

These are in fact, prismoids, of which the end sections are equal and similar: and as all sections of a prism, parallel to the base, must be also equal and similar, therefore the sides of those sections do not diminish, and

$f$  and  $c$ , the diminutions of the prismoid, when it becomes a prism, vanish, or become  $= 0$ .

Substituting then in equation A, zero for  $f$  and  $c$ , we have,

$$\left( (ab - (b \times o) - (a \times o) + (o \times o)) + (4ab - (2b \times o) - (2a \times o) + (o \times o)) \times (ab) \right) \times \frac{1}{6} h = S.$$

Which is equivalent to

$$\left( (ab) + (4ab) + (ab) \right) \times \frac{1}{6} h = S.$$

Whence,  $(6ab) + \frac{1}{6} h = S.$

Or, finally,  $ab \times h = S.$

which is the usual rule for finding the solidity of a prism, or cylinder.

### 2. Pyramids.

A pyramid may be considered as a prismoid, whose sides diminish by such a ratio, that if the solid were prolonged from the small end, the sides of the rectangular sections, would vanish at the same moment, or concur upon a point, (the vertex of the pyramid); considering the prismoid at this instant, it is evident that the diminutions  $f$  and  $c$ , of the sides of the base, become equal to the sides themselves, and if the base of the pyramid be any rectangle  $a \times b$ , we must, therefore, in equation A, substitute  $a$  for  $c$ , and  $b$  for  $f$ ; and we have,

$$\left( (ab - ba - ab + ba) + (4ab - 2ba - 2ab + ba) + (ab) \right) \times \frac{1}{6} h = S.$$

Whence  $\left( (o) + (ab) + (ab) \right) \times \frac{1}{6} h = S.$

Or,  $(2ab) \times \frac{1}{6} h = S.$

Or, finally,  $ab \times \frac{1}{3} h = S.$

which is, in fact, the common rule laid down in the books, for finding the capacity of a pyramid, or cone.

### 3. Wedges.

If we imagine the sides of the successive sections of a rectangular prismoid, to diminish by such a ratio, that if the solid were prolonged from the small end, they would not all vanish at once; then it will be found that when one pair of sides of the rectangular section disappears, the other pair will coincide, and become a right line, the solid in point of fact, will run to an edge, and the prismoid will be transformed into a wedge. Let the base, or back, of any wedge, be any rectangle  $a \times b$ , and suppose in the prismoid fig. 1, the side  $a$ , to vanish, then it will become a wedge, of which—

$(b - f)$  = the length of the wedge;  $a$  = breadth or thickness of the back;  $b$  = the length of the back. And as the side,  $a$ , is supposed to vanish, it will at the instant of disappearing, become equal to  $c$ , its diminution.

Substitute, therefore, in equation A,  $a$  for  $c$ , and we have,



$$((ab - ab - af + af) + (4ab - 2ab - 2af + af) + (ab)) \times \frac{1}{6} h = S.$$

$$\text{Whence, } (3ab - af) \times \frac{1}{6} h = S.$$

$$\text{Or, finally, } ((b - f) + 2b) \times a \times \frac{1}{6} h = S.$$

But  $(b - f) =$  "length of edge;"  $a =$  "breadth or thickness of back;" and  $2b =$  "twice the length of the back."

Consequently, this expression is in fine, the common rule laid down, by writers on mensuration, for ascertaining the capacity of wedges.

#### 4. Frustra of Pyramids.

We may regard these solids as prismoids, whose sides diminish by a regular proportion to their own lengths, such, that if the solid were prolonged from the small end, all the sides of the rectangular section, would vanish at once, and the solid become a pyramid. Therefore  $f$  and  $c$ , the total diminutions in the sides of the frustrum, or the quantities by which the sides of the top are less than those of the base, must have the same ratio as the sides themselves.

$$\text{Or, } f : c :: b : a.$$

$$\text{Consequently, } bc = af, \text{ and } f = \frac{bc}{a}$$

Now in equation A, substitute  $bc$  for  $af$ , and  $\frac{bc}{a}$  for  $f$ , and we have,

$$((ab - bc - bc + \frac{bc^2}{a}) + (4ab - 2bc - 2bc + \frac{bc^2}{a}) + (ab)) \times \frac{1}{6} h = S.$$

$$\text{Whence, } (6ab - 6bc + \frac{2bc^2}{a}) \times \frac{1}{6} h = S.$$

$$\text{Or, } (3ab - 3bc + \frac{bc^2}{a}) \times \frac{1}{3} h = S.$$

Which may be transformed into

$$((ab - 2bc + \frac{bc^2}{a}) + (ab - bc) + (ab)) \times \frac{1}{3} h = S.$$

But  $(ab - 2bc + \frac{bc^2}{a})$  is the area of the top, when the prismoid becomes a frustrum of a pyramid. And  $(ab) =$  area of base, whilst  $(ab - bc) =$

$\sqrt{ab \times (ab - 2bc + \frac{bc^2}{a})}$  the square root of the product, of the end areas.

Wherefore, the above expression, is merely the usual rule for the capacity of frustra of pyramids, or cones, expressed in Algebraic language.

Besides the applications we have above given, of the prismoid formula to the measure of solidity; it may be employed by simply substituting lines for surfaces, in the measurement of the superficies of triangles, parallelograms, and trapezoids.

For a triangle may be regarded as a rectangular pyramid, of which one side of the base equals zero.

A parallelogram, as a rectangular prism, without thickness.

And a trapesoid, as a wedge on a rectangular back, the side of which is perpendicular to the direction of the edge, or in fact, the thickness of the back = 0.

The prolific formula, of which we have been treating, has also, some other applications in mensuration, such as to determine the solidity of an Hemisphere, and by a slight transformation, to calculate the surfaces of several bodies. But as all these are foreign to the present purpose, the writer does not propose to engage in their discussion.

Oldtown, Md., May 25th, 1840.

### Physical Science.

*Observations on the Tornado which desolated Natchez, on the 7th of May, 1840.* By H. TOOLEY.

The atmospheric temperature, from the first to the sixth day of May, was higher than on the same days of the five preceding years. The range of the Thermometer and Barometer of the days mentioned, together with the winds and weather, will be seen in the following table.

Table.

| Days. | THERMOMETER. |        |          | BAROMETER. |         |          | ATT. THERMOM. |        |          | WIND.<br>DIRECTION<br>AND FORCE. |
|-------|--------------|--------|----------|------------|---------|----------|---------------|--------|----------|----------------------------------|
|       | 6, A. M.     | 12, M. | 6, P. M. | 6, A. M.   | 12, M.  | 6, P. M. | 6, A. M.      | 12, M. | 6, P. M. |                                  |
| 1     | 75           | 79     | 82       | 29,77      | 29,77   | 29,74    | 78            | 79     | 82       | W 3 2, N E 2                     |
| 2     | 75           | 82     | 85       | ,69        | ,67     | ,58      | 77            | 81     | 82       | S 2, SW 3 4 5                    |
| 3     | 76           | 83     | 85       | ,51        | ,52     | ,52      | 78            | 83     | 84       | S W 4 5 3                        |
| 4     | 70           | 82     | 86       | ,64        | ,73     | ,70      | 74            | 83     | 85       | S 2, N 2, N E 2                  |
| 5     | 69           | 79     | 86       | ,72        | ,71     | ,63      | 73            | 79     | 83       | E 3, W 2, N E 2                  |
| 6     | 71           | 83     | 85       | ,60        | ,53     | ,45      | 75            | 81     | 83       | S E 2, S 3 4 5                   |
| Mean, | 72,6         | 81,3   | 84,8     | 29,65,5    | 29,65,5 | 29,60,3  | 75,8          | 81     | 83,3     |                                  |
| 7     | 73           | 80     |          | 29,46      | 29,49   |          | 80            | 80     |          |                                  |

*Remarks on each day.*—1. Darkly overcast all day, and very hazy. 2. Overcast, very hazy; dense cumuli, cirri of every form, windy all night. 3. Large cumuli, under scud 5, thunder, dense cumuli; the evening closes very hazy, but cloudless. 4. Morning clouds, a few cirri, the sun sets brilliantly. 5. Cirri—without a cloud—thin cirri—overcast. 6. Overcast all day, sprinkle of rain.

The seventh day was ushered in densely overcast, and very warm, with a brisk wind at S. 4, increasing at noon, and veering to the E. 5. At meridian, the south-western sky assumed a darker and more tempestuous aspect, and gloom and turbulence increasing every moment. At 12.45 the roar of the approaching storm began to be distinctly heard, the wind blowing a gale, N. E. S. The roar and commotion of the storm, grew more loud and terrific, attended with incessant corruscations and flashes of forked lightning. As the storm approached nearer, the wind veered to the

E. 7. At 1.45 the storm cloud assumed an almost pitchy darkness, curling, rushing, roaring above, below a lurid yellow, dashing upward, and rapidly approaching, striking the Mississippi some six or seven miles below the city, spreading desolation upon each side, the western side being the centre of the annulus. At this time the blackness of darkness overspread the heavens, and when the annulus approached the city, the wind suddenly veered to the S. E. S. attended with such crashing thunder, as shook the solid earth. At two the tornado 10, burst upon the city, dashing diagonally through it, attended with such murky darkness, roaring and crashing, that the citizens saw not, heard not, knew not the wide-wasting destruction around them. The rush of the tornado over the city, occupied a space of time not exceeding five minutes, the destructive blast not more than a few seconds. At this moment the barometer fell to 29.37.

The storm passed over, a comparative calm ensues. The affrighted and terror smitten inhabitants arouse from their stupor, breathe more freely, and see around them an appalling spectacle. Every building in the city more or less injured, many utterly demolished, and very many unroofed, with their walls more or less broken and thrown down; every tree and fence prostrated, and the street filled with scattered fragments of every kind, and nearly impassable.

The tornado, in its course, passed over Natchez under the hill, and swept it with the besom of destruction, overthrowing, crashing and demolishing almost every house, shop, and building, and at one fell swoop reduced that part of the city to undistinguished ruin. Three steamboats broke from their mooring; their upper works are blown off as feathers; two of them capsize and sink, and nearly all their crews and passengers perish in the storm river flood. More than sixty flat-boats, laden with up country produce, break from their fastenings, and with their crews disappear.

The tornado in its course from the south-west, passed centrally through the plantation of Walton Smith, Esq., on the western side of the Mississippi, seven miles below Natchez, devastating every thing in its passage; thence up the river, the centre of the annulus being on the western side, and in its passage spread destruction on the plantations and forests for half a mile in width, westwardly, and left the western bank at the bend above Natchez, crossing above and continuing its devastating course to the northeast. Opposite Natchez, the centre of the annulus was in the river on the western side, the river being about six-tenths of a mile wide. The wind that desolated Natchez, was from the southeast, blowing inward to the annulus, and onward, forming a curve as it touched the annulus.

In the course of the tornado over the city, in hundreds of instances, proof irresistible was shown, that in the rush of the storm over a house, the external atmospheric pressure was so taken off that the atmosphere within the house suddenly expanded, so as to force an outlet, either by blowing off the roof, bursting open doors and windows, driving outward gable ends, or the whole or parts of walls; on the contrary, where leeward doors, or windows, or the trap doors of roofs were open, no such destructive effects were produced. For proof of this one meteorological fact, the following cases out of very many, will suffice.

1. The garret of a brick house occupied by Thomas Armat, Esq., as an office, was closely shut up, both ends burst outward, and such was the force of the explosive power, that some of the bricks of the windward end, were thrown upon a terrace nearly on a level with the end, and at a distance of not less than twenty feet, in the face of the storm.



2. A brick house on the north side of Main street, belonging to John Fletcher, had the leeward gable end thrown out, the windward end remaining uninjured.

3. The windward gable end of a large house adjoining the Commercial Bank, burst outward against the face of the storm, the leeward end was uninjured.

4. The gable ends of a large three story brick house, on Franklin street, owned by Rowan and Cartwright, were thrown outward with great force.

5. The front ends (leeward to the storm,) of two brick stores, owned by Eli Montgomery, were thrown outward with great force, the windward ends being uninjured.

6. Another large brick house, near the last just mentioned, owned by Watt, Burke & Co. had the leeward side nearly demolished.

7. Another brick house adjoining the last mentioned had the windward gable end thrown outward.

8. The roof of the Theatre, a large brick building, had the entire roof blown off and thrown some ten feet forward, and the walls demolished.

9. The leeward walls of two front rooms of the Tremont House, on Wall street, were thrown outward with great force, without destroying or moving the furniture therein, and where the storm could have no access.

10. The roof of the fire-proof brick office of the Probate Court, exploded to windward, that side, it is presumed, being the weakest.

11. The gable ends of a large brick store on Main and Pearl streets, were thrown outward with great force.

12. The southern side, and the northern and western gable ends of the brick Insurance buildings, on Pearl and Market streets, were thrown outward with such force, as to nearly demolish the building.

13. The roof of Doctor Merrill's house on State street, was saved by the explosive power bursting open a large trap door in the roof, thereby making an outlet for the expanded air.

14. The leeward wall of a new wooden house, owned by Rhosa Parker, on Washington street, was thrown outward by the explosive power, the windward side and end remaining unbroken, excepting the glass of the windows. Hundreds of facts, if need be, might be adduced to prove that when there were no sufficient openings, to let out the expanded air, the roof, or some other part of the house gave way, most generally the leeward.

The quantity of rain that fell, during the passage of the tornado, over the city was only 0.83 of an inch, holding in suspension so much mud and minute particles of leaves and other vegetable matter, as to be impervious to sight, and leaving a thick coating upon whatsoever it came in contact.

This brief account of the tornado, will be closed by presenting to those who are skilled in the physiology of plants, for further investigation, the following facts.

The effects of the storm upon the leaves, and buds of plants, was in a manner to sear them, abstracting or destroying so much of their vitality, that such as did not die outright, were crisped, and their growth so suspended, that it was for ten or more days, before they resuscitated, and began again to grow. Some very thriving grape cuttings, in the garden of the writer of this paper, were killed, and the old vines stunted. Even the leaves of the succulent *Morus Multicaulis*, appeared as if an eastern sirocco had passed over them. A luxuriant arbor vita in the writer's yard, appears blighted and dying. Fruit trees, and grass, and weeds, put on the same appearance.

Southwick, Massachusetts, June 16th, 1840.

*Observations on the Auroral Arch seen on the 29th of May, 1840.* By  
A. HOLCOMB.

DEAR SIR,—Agreeably to your request, I send you an account of the observations I made at the time of the auroral arch, seen on the evening of May 29th, 1840. There were some unusual appearances before 9 o'clock, in the neighborhood, or near where the arch afterwards appeared. A light streak resembling the sun shining on a cloud, was seen in the east, running N. E. and S. W. Another was seen in the south. No very special notice, however, was taken of them at the time. I was observing double stars that evening most of the time, but was not observing at the moment the arch commenced. I first saw it at 9h. 15m., it might have commenced five minutes sooner. At 9h. 20m. it passed over  $\epsilon$  Bootes, and  $\mu$  Leonis, or point of the sickle, and about one degree south of the Beehive, in Cancer.

It did not extend at any time, but a few degrees west of the Beehive, not reaching to the western horizon. It was the most brilliant at about 9h. 25m. At 9h. 30m. it began to be irregular, with many brilliant spots, like the setting sun shining on curdled clouds. At this time also, it began to be double through a considerable portion of its length, (that is) from Arcturus to Leo. At 9h. 35m., it passed over Arcturus and Regulus. At this time waves resembling fog, driven by wind, were seen commencing near Arcturus, and running rapidly to the west. At 9h. 40m. it wholly disappeared. Many shooting stars appeared in the neighborhood of the arch, during its continuance. Very light in the north, both before the arch appeared, and afterwards. The arch was not at right angles, with the magnetic meridian, the eastern part being farther south than the western. This arch strongly resembled that of May 8th, 1836, with this difference, however, that of 1836 varied more from the magnetic east and west, than that of 1840. The eastern portion of the former, (before it disappeared,) passed six degrees south of Arcturus, whereas the western part passed between Regulus and Gamma Leonis. That of 1836 when it first appeared, passed over  $\epsilon$  Bootes at 9h. 30m., which varied only ten minutes from the time of the present one, passing over the same star.

I think you informed me that it was not seen in Philadelphia, until after 10 o'clock. This is somewhat strange, for what should have rendered it invisible? Was it too low to be seen? Or not in a right position with respect to the eye? Was the same arch, when diminishing in splendor here, increasing in splendor farther south? It certainly had the appearance of becoming extinct, not merely of passing out of sight. It is probable that a different arch was seen in Philadelphia, from the one seen here, and also, probable that these auroral arches, are not so high as some here supposed them to be. You will be puzzled, I think, to ascertain the height of the present one, from the observations here, and at Philadelphia. I have no account of observations made at other places.

Yours, &c.

AMASA HOLCOMB.

SEARS C. WALKER, Esq.

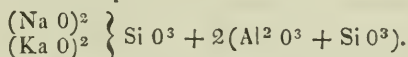
*Notice of a few of the subjects contained in Poggendorf's Annals for 1840.*

By J. C. BOOTH.

Several subjects of great interest both with reference to Chemistry and Physics are to be found in the "Annalen" for the present year, four numbers of which having been received, we hasten to lay a sketch of them before the readers of the Journal. C. Kersten has proved the existence of a lower oxide of titanium, than that generally known as titanous acid, it having been supposed to exist from analogy and from the discovery of a protochloride. It may be obtained by fusing titanous acid, and bi-phosphate of soda in a platinum crucible, transferring the mass to a green glass tube, and while heated intensely, passing dry hydrogen over it. By dissolving the salt in water, protoxide of titanium remains of a beautiful lavender-blue color. From observation, he was led to the supposition, that the blue color of slags from an iron-furnace, was due to the presence of this oxide, since titanous acid is frequently found in iron ores, and might be reduced by intensely fused cast-iron; and by experimenting with the substances of slags, chemically pure, he obtained a similar blue compound, proving the correctness of his supposition. He farther proposes its employment as a blue color, for porcelain, for which purpose it is little inferior to cobalt. Poggendorf remarks on the above, that Berthier in his late work attributed the color of the slag from alais, to titanium.

Several mineral analyses are described, the results of which are the following. V. Ewreinoff analyzed Heterokline from Piedmont, and found it to consist of five parts of oxide of manganese and one of silica. Formula  $5 \text{ Mn}^2 \text{ O}^3 + \text{Si O}^3$ .

Th. Scheerer has shown by thirteen analyses, that nepheline, elæolite, and cancrinite, are identical, and that the formula for this genus of minerals, is three atoms of silica, two of alumina, and two of alkali, (potassa and soda,) which may be thus expressed:



Dr. Petrina, of Linz, described a Kaleidopolaroscope, which, he observes, produces figures of extraordinary beauty, and is at the same time a very delicate test for polarized light. To make this instrument, one of Nicol's prisms of double-spar is placed in the opening of a common kaleidoscope, to which the eye of the observer is applied. Instead of the usual colored articles, which are placed at the other end, between two thin glass plates, he employed foliæ of (gypsum) selenite, of different forms and thickness.

An additional series of "Poggendorf's Annalen," has been commenced, comprising articles on Physics and Chemistry, which have appeared in other countries, and on reviewing the two numbers we have received the present year, we are pleased to find translations of Dr. Henry's treatise on electro-dynamic induction, and Prof. A. D. Bache's essay on "the influence of wind on the quantity of rain obtained in rain gauges." There is also an extract from Dr. Julius' work, on the "state of morals and manners in the United States," relative to the former saline nature of our northern lakes. This work, containing the views of Dr. Julius, deduced from personal observation, during the years 1834—5 and 6, should be translated, not merely because it embodies his views, relative to our morals and manners, but also, contains much information, that would be interesting in a scientific light.



## Franklin Institute.

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Conversation Meeting.

The ninth Conversation Meeting of the season was held at the Hall of the Institute on Thursday evening, May 28th, 1840. The concourse of members was large, and the advantage of such meetings, for purposes of scientific and technical communication, was fully illustrated on this occasion.

Among the interesting objects presented for exhibition was a native *Magnet*, or loadstone, one of the largest probably that has ever been mounted, weighing not less than 34 lbs., and possessing considerable power. It was deposited by Mr. Schnaitmann, 206 north Second street, and is offered for sale. It is said to have been brought from Australia.

A patent *Water and Provision Cooler* was left for exhibition by Mr. David Evans, No. 76 south Second street, and is regarded as possessing some peculiar advantages. It is of a cylindrical form, and contains a filter, of the kind constructed by Mr. Sanderson, by means of which cold and pure water is drawn from a stopcock at the side, while sufficient space is reserved for provisions and ice within. It has been mentioned that the zinc lining of refrigerators is liable to oxidize, especially by the presence of acids or acidifiable substances. The remedies suggested, if any be needed, are the application of paint, or the substitution of lead, which, however, should not come in contact with articles of food.

Messrs. Carr and Keim, 33 Commerce street, deposited several interesting articles of hardware and ironware, as specimens of their stock. Among them was *Morrison's Counter-scale*, differing from that of Fairbanks in having the weights applied at the end of the beam; while it possesses the compactness of the latter, so desirable for grocers and others who employ small weights. Also *Ship Spikes* from the Albany Iron Works at Troy, N. Y., called hammered spikes in contradistinction from the pressed spikes of Burden; and another specimen of the same *coated* with a metallic composition, by a new process invented by Mr. Loring of Philadelphia, to act galvanically in protecting them from oxidation. Also andirons coated in the same manner, and a variety of plates, kettles, bakers, &c., from the Hollow Ware Foundry of Savary & Co., Front street below Reed. Also friction rollers of superior quality, and a variety of patterns of door latches, partly of cast and partly of wrought iron, made by Parker and White, of Meriden, Conn. A fine specimen of English and Huber's coffee mills was exhibited by Mr. Zell, 298 Market street, who has them for sale.

The entertainment of the evening was greatly enhanced by an address from Dr. Hare, concerning some interesting experiments recently made by him, relating to Caloric and Meteorology. It has been generally supposed, that the cloudiness which appears within the cavity of a receiver rapidly undergoing exhaustion indicates that an increase of humidity is a consequence of rarefaction. Dr. Hare has ascertained, by means of a delicate hygrometer, that dryness ensues in proportion to the extent of the exhaustion. In fact, under these circumstances the space from which the air is withdrawn, takes up moisture in order to replace the aqueous vapour which being associated with the air is removed with it to a commensurate degree.

It is well known that the cavity of any vessel having access to moisture

will become replete with aqueous vapour of a tension corresponding with the temperature, uninfluenced by the density of the contained air, so that the quantity is ultimately uninfluenced by rarefaction of the air. Dr. Hare finds that if air saturated with water be allowed to enter a cavity so supplied with vapour, there will be an excess of moisture which will, consequently, by precipitation, form a cloud, and finally appear in drops like those of dew or rain upon the interior surface of the vessel. Meanwhile the temperature rises and the hygrometer indicates excessive humidity.

Dr. Hare ascribes the upward motion, observed within the sphere of tornadoes or hurricanes, to electrical discharges between the terrestrial surface and the thunder clouds, and surmises that in some cases such discharges may take place in order to establish an equilibrium between the earth and the conducting concentric space beyond the elevation at which the atmosphere is sufficiently dense for electrical insulation.

An interesting specimen of the granular ore of Platinum, consisting of some grains of unusual size, some of which were worn into the shape of pebbles, was exhibited by Dr. Hare. Also some very handsome globules of Potassium, being a part of an aggregate of more than six ounces, obtained at one operation by a process, of which an account was published in the latest volume of the American Philosophical Transactions.

There was also exhibited some copies of medals, formed by galvanic action, by Mr. C. Sheble; and some fine heliographic or photographic portraits taken at the establishment of Mr. R. Cornelius, in Eighth street near Chestnut.

On the whole, the interest of this meeting was well sustained, evincing the constant attention paid by the active members of the Institute to the advancement both of physical science and the mechanic arts.

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#### COMMITTEE ON SCIENCE AND THE ARTS.

##### *Report on the Substitution of Lime for Salt in Preserving Ships.*

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination the propriety of the Substitution of Lime for Salt, as a preservative for Ships: REPORT—

That they are called upon to regret that only a few facts could be brought to bear upon the question, and that the experience of others, as ascertained by an examination of approved works on the preservation of timber, is so limited, as not to permit of their giving a decided answer relative to the beneficial or the injurious effects of lime when used in the manner proposed. The effect of strong caustic alkali upon wood has been a subject of experiment, and resulted in the complete destruction or solution of the ligneous matter;\* but it has been applied in a more diluted state with advantage, to remove and prevent the formation of fungus. The effects produced on vats in which caustic lye is made for domestic purposes, are to soften the texture of the wood in such a manner that the surface and even the interior to a short depth, may be peeled off in long and slender fibres when moist, or in shorter fibres when dry. There are no evidences of decay similar to that arising from rot, but it seems as if the substance cementing the fibres was removed by the alkali, while they are not influenced by it. This wood when dry is more flexible and less elastic, and its surface at least appears

\* Ure's Dictionary, Art. Wood.

to be much lighter from the removal of a portion of matter. It has consequently a diminished hardness.

From the alkaline properties of lime we might infer a similarity in its action to Potassa; an inference confirmed by observation. Wood covered or coated with lime in a moist or dry situation undergoes a similar change externally. There is no appearance of decay, but the fibres may be peeled off, the surface is lighter, softer, more flexible and less elastic. These effects then are similar to those above noticed excepting that they are exhibited in a diminished degree, for the action does not take place to the same depth, nor can the external fibres be removed with the same readiness. When in contact with alkaline substance, the wood does not appear to undergo farther change than that which has been described, but if the contact were broken, there can be little doubt that it might be more readily injured by rot, from the softness of texture it has acquired, unless indeed it has become so impregnated as to obviate decomposing influences. The employment of lime, therefore, may be recommended as a preservative of timber, an opinion strengthened by the experience of ages.

But again, it becomes a question of importance to determine the state of the lime most favourable to its powers of preservation, for it is asserted that where wood remains a length of time in contact with quick lime and water, it suffers a more rapid decomposition than under ordinary circumstances. On the other hand, where wood is frequently washed with a coating of lime suffering a short space of time to elapse between the several applications, the wood is not only perfectly preserved, but often becomes so hard as to blunt the teeth of a saw. In this case, it has become partially carbonated, including even that portion which has penetrated the wood. It would therefore appear to be more advisable, if lime should be substituted for salt in the case proposed, to employ it in a partially carbonated state, which may be attained by slaking quick-lime with a quantity of water, just sufficient to convert it into fine powder and then spreading it on any convenient surface for several weeks prior to its application, in order that it may absorb carbonic acid from the atmosphere.

But in the case referred to, there can be no doubt that a portion of the lime will be in contact with salt water. Can any injurious effect arise from this circumstance? The committee are of opinion that it cannot; for although a portion might be converted into muriate of lime under certain circumstances, the probability is that that portion would be small and not capable of materially affecting the wood, even supposing it should do so injuriously, which the committee have no ground for believing.

Again, to an objection proposed, that lime might generate heat, it may be answered, that lime is known to combine with only one atom or 24 per cent. water, forming the hydrate of lime (slaked lime), and that only during its combination does it evolve caloric; and since it is proposed to employ it in a slaked condition, this objection may be unhesitatingly set aside.

The presence of muriate of magnesia, in common salt, which is the material ordinarily employed for filling the spaces in the sides of a ship, by its strong affinity for water tends to keep the salt constantly in a moistened state and probably communicates no inconsiderable quantity of dampness to the vessel. It is highly probable that the lime would obviate this difficulty from its drying quality. The purifying effects of lime are also well known, and it is not an uncommon practice in the warmer climates of Europe to wash the interior of a ship to prevent and free it from contagion.

To compare the two substances together, it may be stated that salt hard-



ens, while lime rather softens the external parts of wood where they are in contact with it, while both tend to prevent the rot, or the attack of insects; that the salt probably tends to keep the atmosphere of a vessel damp, which lime would not;—that the lime will tend more to purify the air than the salt;—that lime has a less specific gravity than salt and is to be preferred on that account.

The committee, therefore, can perceive no ground of objection to the substitution of slacked lime for salt, for filling the interstices of the sides of a ship, particularly if employed in a partially carbonated state; while at the same time where so much interest is at stake in answering the question, the limited information on the subject which they possess will not allow them to give a decided opinion. In conclusion, they would request those who have observed facts, or acquired information, relative to effects of lime on wood under any circumstances, to communicate them to the Institute, in order that they may be brought before the public.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

Philadelphia, June 11th, 1840.

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## Mechanics' Register.

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LIST OF AMERICAN PATENTS WHICH ISSUED IN MAY, 1839,

*With Remarks and Exemplifications by the Editor.*

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1. For making the *Joints of Stone Pumps*; Abraham Van Voorhes, Hebardsville, Athens county, Ohio, May 3.

The sections of these pumps are to be made of convenient lengths, and they are to be formed with stout flanches at their ends, forming shoulders, by the aid of which, and of iron rings and screw bolts, they may be drawn together. A circular groove is to be made upon the faces of the joints, and oakum, or tarred rope, inserted, to make them air tight; the claims are to “the manner of making the joint air tight by the application and use of the groove and band, and oakum, or tarred rope, in the stone pump, in the manner described.”

2. For an improved *Auger for Boring Earth*; George Page, city of Baltimore, May 3.

This auger is intended, principally, for boring post holes in clayey and other soils adapted thereto, and is similar in its general construction to such as were long since patented and used for that purpose. “The peculiar features of this auger consist in surrounding the cutting apparatus with a rim, and dispensing with the centre piece, or twist, of the common auger.” To this rim the cutters are secured by means of screws, and the claim is to this peculiarity of construction.

3. For improvements in *Fire Arms*; Nathan Starr, Middletown, Middlesex county, Connecticut, May 3.

This gun is of the kind that have a single movable chamber which is raised on a pivot at its rear end to receive the charge, and is then forced down in a line with the barrel, and caused, by an excentric, to enter the rear end of

the barrel to a small distance, a fillet being formed on it for that purpose. The claims made are to the particular arrangement of the parts for effecting this purpose, and there is also a claim to the using the ram-rod, as a bayonet, one end of it being made pointed with that view, and provision being made for fixing it to the gun. The parts described and claimed as new do not present any thing worthy of particular notice, as being superior to others previously made for the same purpose.

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4. For a machine for *Cutting Staves, Slats, Laths, &c.*; Hardin Branch, city of New York, May 3.

This machine consists of a wheel which is to revolve, and has knives on its face for cutting thin pieces of wood, from blocks, strips, or bolts, operating precisely in the manner of other known machines. The patentee says that, "having given a description of the machine to which I apply my invention, I do hereby declare that I do not claim any part of said machine as of my invention; but what is claimed as new, and desired to be secured by letters patent, consists in the employment of the cast iron stocks constructed as described, for holding and securing the cutting tools to the wheel, for cutting thin pieces of wood from solid blocks." The cast iron stocks, so called for holding the cutters, are undoubtedly good things, but there is very little of novelty in them, as they consist merely of iron bed plates to which the cutters are attached by screws, in the common mode of managing such matters. The patentee has no ground to complain of the want of a liberal disposition in the office, so far as concerns the case before us.

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5. For a machine for *Raising Canal Boats, for repair*; N. N. Penrose, and S. F. Palmer, Beaver Meadows, Luzerne county, Pennsylvania, May 11.

"The nature of our invention consists in raising a boat in a swinging position, by means of levers, or balance beams, connected to frames which may be easily changed from one position to another, which is frequently necessary to work under the bottom of a vessel." The boat is to be raised by means of levers, to the short arms of which are attached frames of sufficient size to surround the boat, and these are to be let down into the water, so that the boat may enter them. To the long ends of the levers a box, or trunk, is attached, into which water may be poured, so as to raise and balance the boat. The levers are sustained on stout stone posts, which have their fulcrum placed upon them.

The claims are to "the mode of raising and suspending boats for repair by vibrating lever frames, combined with longitudinal and transverse frames attached to the ends thereof; one set of transverse frames at the short ends of the lever frames containing the vessel to be raised, another set of transverse frames at the long ends of the lever frames suspending a trunk of water for balancing the boat."

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6. For an improvement in *Steam Boiler Furnaces*; Lucien Mailard, city of New York, May 18.

This improvement it is said, "will give an economy of more than one-third of the consumption of fuel, by the combustion of *dead steam*." A gift, certainly, of no small importance. By *dead steam*, is meant that which has performed its office in the cylinder, and this is conducted through suitable tubes into hollow grate bars, under the furnaces of high pressure boilers,

whether of locomotive or other steam engines. From the hollow bars the steam is to enter the fire through numerous holes in them, made for that purpose.

*Claim.*—"I do not claim as my invention the introduction of waste steam into, or amidst, the red hot incandescent coals in the furnace for the purpose of increasing combustion by its decomposition, this having been previously done, but not in the manner in which I effect it. I therefore claim as my invention and desire to secure by letters patent, the introduction of waste steam on, or amidst, the red hot incandescent coals, by means of the arrangement of conical tubes, and hollow perforated bars, on which the coals rest, in the manner described."

There are several grave questions connected with the invention that is the subject of this patent, which we have not time to discuss, but which we will not entirely dismiss. To the theory that the water is decomposed, and aids the combustion in consequence of this decomposition, we have not yet, and do not now, give our assent; but this is a matter of no importance practically, provided the combustion be actually rendered more efficient by its agency, which we do not dispute. Steam, and water, have been carried into hollow perforated bars, with the same view as that above declared, but, so far as we are informed, the plan has been universally abandoned. The bars must, necessarily, when in contact with the fire, be frequently out of order. In locomotive engines the waste steam is wanted to increase the draught in the chimney, and if diverted from this object, and applied elsewhere, a balance of accounts will have to be struck, and this, we apprehend, would be against the sending the waste steam into hollow bars, so far as locomotives are concerned.

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7. For improvement in *Rail Road Cars*; Lewis J. Germain, Catskill, Green county, New York, May 7.

The patentee has represented a six wheeled car, having a separate frame for each pair of wheels, and these frames operating upon each other, by means of a toothed segment and rack, or by means of jointed cross bars, on the middles of their sides of contact, these devices being substantially the same with others heretofore adopted. The middle frame of the three which sustains the axles, is so connected with the general car body frame above them, as to allow a certain degree of vertical play to it, for the purpose of equalizing the bearing of the wheels on the rails; this is effected by means of what are called stands and slides. The wheels are thus to adapt themselves to the curvatures of the road, and to its horizontal deviations. The claims are to the stands and slides in combination with the middle, and top, or body frame, in the manner described; and to the manner of connecting the three axle frames together, by a single or double cross joint, or a rack and segment wheel. The actual novelty of the devices here patented is but small, and we do not see any thing in them to justify high anticipations of their utility.

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8. For an improved *Jack Screw*; Stephen Vail, Speedwell Iron Works, Morris county, New Jersey, May 7.

This jack screw is intended principally for the purpose of lifting locomotives and cars on to the track of a rail road, and to this purpose it appears to be peculiarly well adapted; and it is, of course, also adapted to the raising of heavy bodies of other kinds.

The main lifting screw works through a nut, the standard, or lower



part of which is bifurcated, or divided into two legs, which rest upon a suitable base, to which they are hinged, so as to admit of the head of the main screw being thrown over, its shaft standing out of the perpendicular. The head of this screw has a collar round it within which it can turn, and to this collar is hinged the head of a second screw, which stands at an angle of about  $45^{\circ}$  with the first, and, like it, has a nut with bifurcated legs, hinged to the same base with the former. The two screws, and base, constitute a right-angled triangle when the main screw stands in a vertical position. It will be evident that by the action of these screws a heavy body may be raised, and moved over laterally, as may be required. The claim is to "the combining together the two screws in the manner above set forth; that is to say, by giving to their standards a hinge motion on the platform or base of the apparatus, and by connecting them to each other at their upper ends by a joint, whilst they are allowed to turn freely by the arrangement of the collars and swivels, or by some analogous contrivance; by which arrangement the locomotive, or other heavy body, to be raised, may be first lifted vertically, and then moved laterally; for the purpose, and substantially in the manner, set forth."

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9. For *Earthen or Cement Pipes, for conveying water*; Charles Stearns, Springfield, Hampden county, Massachusetts, May 8.

These pipes, or trunks, for the conveyance of water, &c., are to be made of flat rectangular pieces of earthen ware, properly baked, and having holes in the upper and lower pieces for the insertion of screw bolts, to hold them together. The side pieces are to enter channels provided in the top and bottom pieces for that purpose. The parts are to be put together with cement between the joints. "The invention claimed consists in the before described mode of making pipes, or conduits for conveying water, &c.; that is to say, with rectangular pieces of burnt clay, channeled on each side of their inner surface to receive the pieces forming the sides of the tube; and also the method of fastening them together with bolts, all substantially as above described."

These trunks are, of course, intended to bear a pressure of water, and are to be substituted for pipes of wood and iron, but as they are made of brittle materials, entirely unyielding, they will be liable to fracture should there be the most trifling settling of the ground in which they are laid; an event which it is scarcely possible to guard against, although the utmost care and skill may be employed; we are very apprehensive, therefore, that the proposed plan, if tried, will be soon abandoned. Besides this objection, it will be found to be a thing of extreme difficulty to join the respective pieces together so that they shall be water tight.

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10. For an improvement in *Applying Heated Air to Furnaces, Economizing fuel and consuming Smoke*; Frederick P. Dimpfel, city of New York, May 9.

By the improvements in the supplying of heated air to furnaces which form the subject matter of this patent, we are informed that "a great saving is effected in the quantity of fuel employed; the smoke and combustible gases which ordinarily escape combustion are wholly or in great part consumed, and the sparks given off by the fuel are arrested."

A good general idea of the construction of the apparatus may be obtained from the claim, which is as follows, "What I claim as my invention,

and desire to secure by letters patent, in the above described apparatus, is the employment of a box, or receptacle, constructed in the manner set forth, and which is to contain a stratum of pebble stones, or of any other material which will leave interstices through which air may be forced to pass, but which will have the effect of producing pressure within the furnace, which is supplied with air from a suitable blowing apparatus, and in which furnace the air is to be forced into a closed ash pit, the whole being combined and arranged substantially in the manner set forth.

"I also claim the mode described of forcing in with the atmospheric air a portion of that which has previously passed through the fire; by which means it is made to enter in consequence of the pressure to which it is subjected. I claim, likewise, the manner of shutting off the draught from the blowing apparatus, by the opening of the door for feeding the fire, as set forth."

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11. For an improvement in the *Blacksmiths' Tuyere Iron*; John Shugert, Elizabeth, Allegheny county, Pennsylvania, May 9, Antidated December 21st, 1838.

The patentee says, that "the improvement which I am about to describe, is on the tew-iron, for which I obtained letters patent of the United States, dated the thirty first day of March, 1836, in which the blast from the tew-iron entered the fire at an inclination, say of 45°. This elevation of the blast was found to produce beneficial results; but some inconvenience was experienced from the tendency of the coal to rise, or fly up, when the blast was given with considerable force, through a round nozzle; an inconvenience which is effectually removed by my present improvement, which is productive also, of other advantages." This improved plan consists in making the opening in the furge back oblong, instead of round; say from two to four inches in length, and from three eighths of an inch to an inch in height; the tube leading to this opening, is to assume the proper form as it approaches it, and it may be divided horizontally, by one or more partitions, which will prevent the falling in of coal, through the openings. The claim is to the oblong form given to the openings, in combination with the elevated blast.

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12. For an improvement in the *Fire Engine*; John Williams, Jr., Salem, Washington county, New York, May 11.

"The nature of my invention, consists in applying the power of the firemen, directly on the piston of a fire engine, without the intervention of levers, or breaks, which are commonly used for that purpose." The manner of effecting this object, is so clearly set forth in the claim, that no further description of it, appears to be necessary; this is to "the having a vertical cylinder in the centre of the body, or box thereof, with arms duly braced, projecting radially from the piston rod, with the outer ends attached to a hoop, or merely extending out, so as to be grasped by the hands; by which arrangement the engine is rendered so compact as to adapt it to steam boats, and to other situations, where economy of room is important, whilst at the same time, a sufficient power can be applied to it, to render it an efficient instrument."

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13. For an improvement in the *Machine for Drilling Rock*; Isaac H. Singer, Lockport, Will county, Illinois, May 16.

Several machines have been patented for the drilling of stone, but they

have, so far as we have heard the results, proved to be failures. The general object of these machines, is to facilitate the manner of working the drill up and down. The machine before us, has considerable complexity, and the references made to the drawings, are numerous, but the claims are limited to the combination of the frame in which the drill works, with the frame of the driving power, by means of an arm, as described. The drill stock, the jaws, and a pin, constructed and combined as set forth; and the peculiar form of the drill, or cutting portion. This peculiar form of the drill is thus described: "It is formed with two broad ends, or transverse cutting edges, with the bottom cutting edge, formed obliquely, from one of the broad ends to the other, these broad, or transverse, ends, are formed circular, corresponding with the circumference of the hole." The face of the drill, in fact, bears some resemblance to the letter N; a shape which it will be no easy matter to sharpen, although this has to be very frequently done.

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14. For an improvement in the construction of *Presses*; John J. Wise, city of Baltimore, Maryland, May 16.

There appears to be considerable novelty in this press, but we are very apprehensive that its merit will consist more in this than in its special adaptation, to the purpose of pressing. Its operation is like that of the screw press, but it is without a screw, the office performed by the thread and nut, in that power, being effected by inclined planes, formed on the transverse sections of a divided shaft.

There are two followers which are connected to the cheeks of the press by palls, or catches, said cheeks being notched for that purpose. The lower follower is to press the goods, and between the two is a vertical cylindrical shaft, divided transversely, and having its upper portion fastened to the upper follower, whilst the lower portion which is pointed, or formed conically, at its lower end, bears on the lower follower. The section of the shaft, is divided into three equal inclined planes, having vertical offsets at their terminations; and when the lower portion of the shaft is turned by means of a lever, one third of a circle, the lower follower will be forced down to a distance, equal to that of the obliquity of the planes, and the palls will catch upon the cheeks; when the planes are so turned, that their vertical offsets coincide, the upper follower will then fall, and its palls engage with the cheeks; when the operation is to be repeated. Friction rollers, or balls, it is said, may be interposed between the inclined planes. We shall not repeat the form of the claim, as it is to the peculiar mode of construction, above pointed out.

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15. For a *Thrashing Machine*; Jeremiah Wrighton, Tobacco-stick, Dorchester county, Maryland, May 17.

The claim under this patent is very brief, being to "the employment of cutting teeth in the front row of the concave, in the manner and for the purpose specified." These teeth forming the front row in the concave, or bed, "are made of steel, and sharp in front, to cut off all straw that enters crosswise, or would double round, if the teeth were not sharp."

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16. For a *Horizontal, Spiral Bucket, Water Wheel*; Lorenzo Dow Adkins, Perry, Wayne county, Ohio, May 17.

This wheel consists of a right and left handed spiral, or screw, meeting



in the centre of a shaft, and enclosed in a cylindrical case, which it must fit as nearly as may be. The water is to be let in through a trunk, at the middle of the case. The claims are in conformity with this arrangement. The spiral shaft will undoubtedly revolve under this construction, but the plan will not effect a general revolution in the manner of applying the power of water in mills.

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17. For improvements in the manner of constructing *Balance Locks for Canals*; Josiah White, city of Philadelphia, May 17.

The construction of this balance lock is, in general, similar to such as are described in the books, but it contains some improvements, which appear likely to render it more stable and efficient, than those heretofore essayed. The points claimed, are the following:

1st. "The employment of drums without gudgeons, and sustained on friction wheels, or rollers, as a substitute for the shafts and wheels, or pulleys, heretofore employed over the chambers of balance locks.

2nd. "The manner of employing bands of rolled iron, or steel, instead of chains, by which to suspend the caissons, or boxes, as described.

3rd. "The attaching the ends of the double bands of iron, or steel, to a vibrating lever, for the purpose of giving an equal tension to such bands.

4th. "The hanging the pool gates in movable frames, sliding in grooves, and adjusted by screws, for the purpose of adapting the said gates to the varying height of the water in the respective levels, as described."

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18. For improved *Ships' Galleys, for Distilling Salt Water*; Enoch Hutchinson, city of Baltimore, May 20.

The sides of this galley are to be made double, to admit the salt water, between them, which water is to be evaporated by the heat of the fire; the general principle is well known, and the patentee limits his claims, therefore, to the peculiar manner in which he has arranged the respective parts. These we shall not take the time and space to describe, as we are of opinion, that we should not by so doing, render any essential service, either to the patentee, or to the public, and should impose upon ourselves, the further task of assigning our reasons for not believing the plan to be one of any special merit.

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19. For a *Cooking Stove*; Darius Buck, city of Albany, New York, May 20.

In this stove, the fire chamber is above the oven, as in some other stoves, the special feature of novelty relied upon, consisting in enlarging the oven by carrying it under the lap, or hearth, in front of the stove. There is, of course, a downward draught from the fire, the flues from which are directed under and around the oven, in the manner pointed out in the specification. The downward, or reverberating flues are disclaimed, as are certain other parts described, the claims made, being to "the extending of the oven under the apron or open hearth of the stove, and the combination thereof, with the flues constructed as above specified; by which means I am enabled to obtain greater room for baking and other cooking purposes, and effect a greater saving of expense and fuel, than in cooking stoves of the ordinary construction."

20. For improvements in the *Roller Gin*, for ginning cotton; William Whittemore, Jr., West Cambridge, Massachusetts, May 25.

The claim is to the mode of scoring or grooving the surface of the lower roller, in the manner and for the purpose mentioned." And it is said in the specification that the surface of the lower roller, which is formed of iron, is to have its surface scored, or indented, with a file, "or otherwise properly prepared for the purpose of causing the cotton to pass more readily between it and the upper roller."

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21. For improvements in *Cooking Stoves*; Micah Ketchum, Boston, Suffolk county, Massachusetts, May 25.

The only claim made under this patent, is to a "movable front fire plate, for the object and purposes set forth." This stove has a rotary top, very similar to those used in Stanley's, and other, stoves. Behind the fire chamber there is an oven, having a flue passing down in front of, and above it. The back plate of the fire chamber, constitutes the front plate of the front flue, and this plate is made capable of being raised up for the purpose of clearing out ashes from the flue. This, although the only thing claimed, does not appear to us, to be a very eligible mode of accomplishing the object intended, and we suppose that it stands alone, in consequence of the other devices described not having any claim to novelty. We have no doubt that the stove is a good one, but it does not appear to present any broad claim to invention.

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22. For an improvement in *Tanning*; William Herapath, city of Bristol, Great Britain, May 30.

The commencement of the specification of this patent is in the following words:

"I, William Herapath, of the city of Bristol, in the United Kingdom of Great Britain, hereby make oath, that I am the sole inventor of the system of tanning, by repeatedly passing hides, or skins, (connected together) between rollers placed over, or in, tan pits, described in the specification hereunto annexed, and for which a patent has been granted unto me, in connexion with James F. Cox, for fourteen years, from the 16th day of November, 1837, and the specification for the same, was published the 15th day of May, 1838, in England, in manner following."

The specification of this patent, is published in Vol. X, of the Repertory of Patent Inventions, for 1838. The claims made, are in the following terms.

"Having now fully described our said invention, and the manner in which the same is performed, we declare that we do not claim any parts of the machinery hereinbefore described, as being in themselves new, or newly combined; but what we claim as new, and of our invention, is the tanning of hides and skins, by connecting, or fastening them together, as hereinbefore directed, for the purpose of subjecting them to a quick and repeated alternation of absorption and expression, (absorption of fresh tanning liquor, and expression of the liquor when exhausted of its tannin, or partially so,) by means of a continuous application of one, two, or more, rollers, placed, adjusted, moved and regulated, and fed and supplied, in the manner hereinbefore directed; and such our invention being, to the best of our knowledge and belief, entirely new, and never before used. I do hereby declare this to be our specification of the same, and that I do verily believe this our

specification doth comply in all respects, fully, and without reserve or disguise, with the proviso in the said herein before in part recited letters patent contained; wherefore we do hereby claim to maintain exclusive right and privilege to our said invention."

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23. For *Pantaloons Straps*; W. H. Simpson, Boston, Massachusetts, May 30.

The nature of this invention will be understood by the claim, which is to "the mode described of constructing spring straps, for pantaloons, by attaching a simple coiled spring of wire, made flat, to the end pieces, by which the strap is to be attached to the pantaloons." This flat coiled spring is to extend entirely across, under the foot.

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24. For an improvement in the machines for *Crimping Boot Legs*; John Goodwin, Jr. Sterling, Worcester county, Massachusetts, May 30.

This crimping machine differs so little from some of its compeers and predecessors, as to render it unnecessary to give a description of it. By the devices claimed, the patentee believes, that he has rendered the machine more equal in its action, than those previously patented.

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#### Progress of Practical and Theoretical Mechanics and Chemistry.

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*Description of the Turbine, or French and German Water Wheels.* By GEORGE RENNIE, Esq., F.R.S., &c. &c. *From the Railway Magazine.*

[In the course of some conversation we lately had with Mr. Rennie on this famed instrument, he informed us that he had seen one of them in France, whereupon we requested him to favour us with a description of it. This he has kindly done in the following paper, which we have no doubt will be read with great interest in this country. Our curiosity being excited by the care to conceal the invention, we did, between the time of speaking to Mr. Rennie and his sending us the article, consider the subject, and though we had never seen any account or description of the machine beyond the very vague one to the French Academy of Sciences, we hope if we have not Fourneyron's secret, we have something not much worse. We therefore set about preparing a somewhat elaborate paper on it and its application to steam-vessels and locomotives, but having received a much more complete article from Mr. Rennie than we had requested, or expected, we willingly yield the precedence to his, which, we doubt not, will prove infinitely more acceptable to our readers.—ED. R. M., &c.]

It is somewhat remarkable in the annals of invention, that a machine which has excited so much interest in France and Germany, should have escaped the notice of journalists and scientific men\* in this country.† A model of the turbine was brought over to this country a few years since, but nothing has been effected towards putting the principle into operation.

\* In our 23d number, and one or two others, we gave a brief notice of this machine, which subsequently was copied into most of the newspapers. In the first notice there is an error by the translator in the quantity of water expended. It should be 1.06 cubic feet per second.—ED.

† See Jour. Frank. Inst. vol. xxiii, p. 133.



Under these circumstances, a brief account of this curious machine may be interesting.

The turbine is neither more nor less than an improvement on the spiral wheel of the East, and the horizontal wheels so often met with in the south of France, Spain, Portugal, and Italy. Plates, and descriptions of these wheels, may be seen in the works of Zonca, Bockler, Ramelli, Walter, and Belidor; with this difference, however, that the water acts principally by its impulse.

Monsieur Naviere, in his notes on "Belidor's Architecture Hydraulique," gives the theory of the horizontal wheels which are employed at Toulouse and in the Pyrénées. In these examples the water acts by percussion only, and the result of the experiments of Messrs. Tardy and Piobert give about 0.34 of the power expended for the useful effect, while according to M. Poncelet's experiments in 1825, only  $\frac{1}{15}$  of the power expended was rendered useful. M. Poncelet, whose researches in hydraulic science have been so valuable, gave, in 1826, a theory for the curves of an horizontal wheel, on the principle of reaction, namely, that the water should enter the wheel at the circumference and leave it at the interior, without velocity. In 1833, M. Burdin (engineer of mines), proposed to construct another kind of wheel, which he designated turbine, but in 1823, previously in the year, M. Fourneyron had directed his attention to this machine, which, with unwearied perseverance, he succeeded in perfecting in the year 1833.

The machine of M. Burdin receives the water at the top of a cylinder, or vertical drum, and rejects it at the lower end. The water then flows either nearer or further from the circumference, according to the forms of the curves on the surface of the cylinder, the height of which should be regulated to half the height of the entire fall; whereas in the turbines of Fourneyron, the thickness of the cylinder is only a few inches. The water issues out of the curves horizontally from the interior of the cylinder, and penetrates in every direction the counter curves of the exterior-wheel, and escapes horizontally through vertical openings in the exterior-wheel; or, to simplify the explanation, we have only to imagine a wheel with curved buckets laid horizontally, and the column of water issuing from the centre to the circumference, or by reversing the system, cause the water to issue from the circumference towards the centre. So far the principle. But the main difficulty lies in the construction, and this M. Fourneyron has acquired by long experience.

Two turbines, constructed by M. Fourneyron, were experimented upon by M. Morin (so well known for his valuable experiments on friction, &c., &c.), one at Moussay, in the Vosges, and the other at Müllback, in the department of the Lower Rhine. The former has a fall of three metres, or 9.84 feet, and the latter a fall of seven or eight metres, or from 23 to 26 feet. The effects were measured by the friction lever of M. Prony, which was applied to the vertical axes of the turbines, and although the velocity of the turbine varied from 140 to 180 revolutions per minute, the difference between the actual expenditure, disposable effect of the fall, exceeded it only by  $\frac{1}{17}$ . It results from the experiments of M. Morin, first, that the wheel of Moussay of two feet nine inches diameter, and four and one-third inches in thickness, on a fall of twenty-four feet six inches, is equal to 45 horses, and, secondly, that from 180 to 290 turns per minute the useful effect is 69 per cent., and which is very little diminished when the wheel is drowned.

The results of M. Morin's experiments on the turbine of Müllback, were:

1st. That the wheel of the turbine having a diameter of  $6\frac{1}{2}$  feet, and a thickness of one foot, and a fall of from  $11\frac{1}{2}$  to 12 feet, transmits a useful effect of 91 horses.

2d. That at the velocity of from 50 to 60 turns per minute, with the sluice well opened, the useful effect is 78 per cent. of the power expended.

3d. That the velocity of the wheel may be varied very greatly without altering the effect more than from  $\frac{1}{25}$  to  $\frac{1}{30}$  of the maximum effect.

4th. That when the wheel is drowned it makes little difference from the effect when not drowned.

5th. That although the expenditure of the water may vary in quantity in the ratio of from three to five, the useful effect is sensibly the same.

M. Morin has made experiments upon other turbines which have led to similar results. But the results obtained at the spinning factory of M. d'Eichtal, at St. Blaise, in the Black Forest, are curious.

There, the wheel of the turbine is only 21 inches in diameter, the fall 354 feet in height, the number of turns 2,300, and the power 40 (60?) horses.

When at Paris in October, 1838, I was recommended by Messrs. Arago and Morin, to visit the turbine recently erected at St. Maure; circumstances prevented me from having the advantages of M. Morin's company, nevertheless the machine was very politely shown and explained to me. The following is a brief description:—

Diameter of the wheel of the turbine, 5 feet 8 inches.

Breadth of ditto, 10 inches.

Number of turns per minute, 55.

Height of fall, 11 feet.

Estimated power, 40 horses.

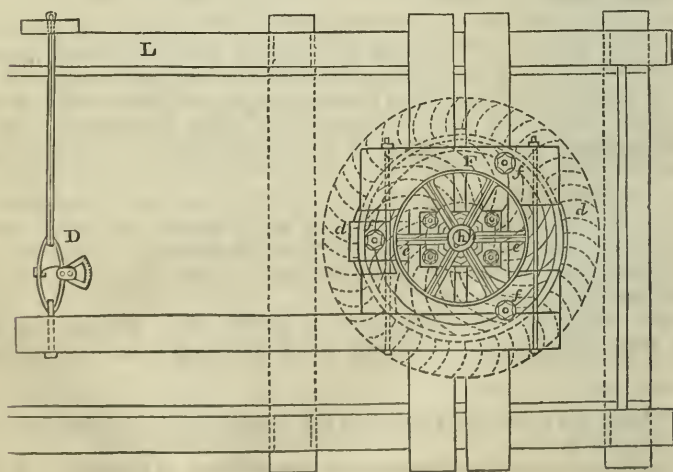
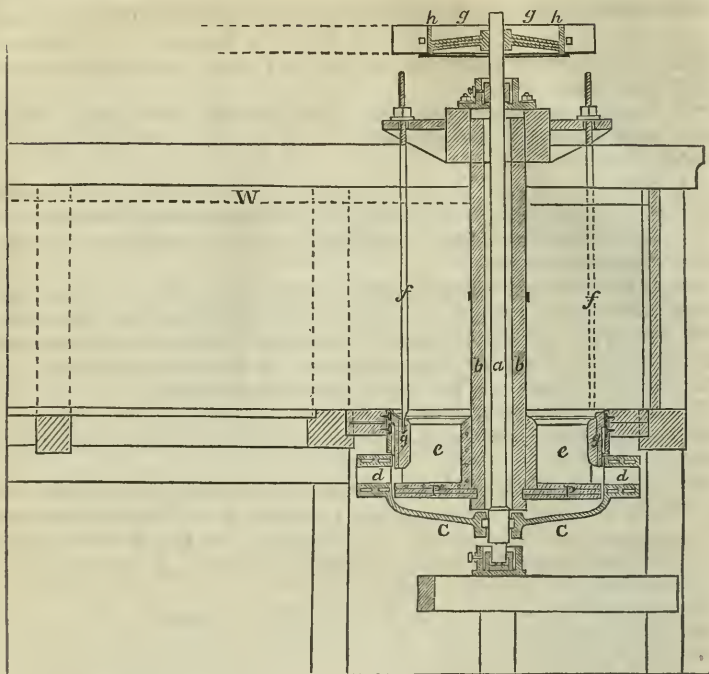
The axle as well as the other machinery, which was polished, had a crown wheel fixed near the bearing of the upper part, sufficiently large in diameter to drive 10 pinions, connected with as many millstones, each 40 inches in diameter, and they were then erecting three similar mills on the same floor, so that there were concentrated 40 pairs of millstones, driven by four turbines, equal in power to 40 horses each, or 160 horses altogether.

The machines were constructed by an English mechanic, established in Paris. I was, however, informed that no one possessed the art of laying out the curves but M. Fourneyron,\* and that the attempt to construct one of these machines without the superintendence of the inventor would be attended with disappointment.

Messrs. Wedding and Carliczect, of Berlin,† have investigated the curves with attention, and find them to be cycloidal. See the annexed plate.

\* We should like to save M. Fourneyron the trouble of guarding this secret any longer.—ED. R. M., &c.

† Versiech mit horizontalen wosserradern, von Wedding et Carliczect.—Berlin, 1837.



12 9 6 3 0 1 2 3 4 5 6 7 Fuss



*Description of the Engraving.*

L, Lever. W, Water level. F, Friction wheel. D, Dynamometer.

a, Main axle of the machine.

bb, Pipe which incloses it.

cc, Disk of the turbine fixed on the main axle.

ee, Curves or disks let into the platform PP.

dd, Curves on disks fixed round the circumference of the turbine, on which the water issuing out of the curves of platform PP, impinges.

ff, Bolts and screws for raising or lowering the circular sluice gg.

Operation.—To set the machine in motion the sluice gg is drawn up by means of the screws and bolts ff.

The water, which is continually resting on the platform PP, with the pressure of the whole fall, immediately issues out between the curve disks, and, impinging on the exterior curves of the turbine, causes it and the main axle, with all its machinery, to revolve rapidly.

In the annexed engraving, a friction wheel and friction break are attached to a lever, the vibration of which, and consequent power of the machine, are ascertained by the dynamometer.

The advantages of these machines are their simplicity and economy; they occupy very little room and can be placed in situations where a common vertical water wheel could not. The facility with which their velocities can be increased or diminished renders them well calculated for spinning, or for any mechanical operation which requires uniformity in changes of velocity *ad libitum*, and whereby increase or diminution of velocity may be obtained without the intervention of a train of wheels and their consequent friction and loss of power. To use the words of the commission appointed to examine the report of M. Morin, "The turbine is, of all the hydraulic machines in use, the most effective that has yet been compressed in the smallest form."\*

GEORGE RENNIE.

*New Source of Light.*

M. Seguin has communicated to the Académie des Sciences, at Paris, a memoir on the distillation of animal substances, in which he states, that he has reduced the process to such a degree of simplicity, as to render it profitable for the sake of the products of the distillation. Thus, from the carcass of a horse he obtained, by destructive distillation, 700 cubic feet of gas, suitable for purposes of illumination, 24 lb. of sal ammoniac, and 33 lb. of animal black. The gas obtained was found to be composed of one part of olefiant gas and four of carburetted hydrogen, and might be preserved for months, in contact with water, without being in any way injured, or its brilliancy, as a combustible, impaired. M. Seguin found that 3,234 cubic inches of this gas, when burnt for one hour, gave twice and a half as much light as a Carcel lamp.

Athænum.

*The Clinometer.*

Sir,—This instrument takes its name from two Greek words, signifying a

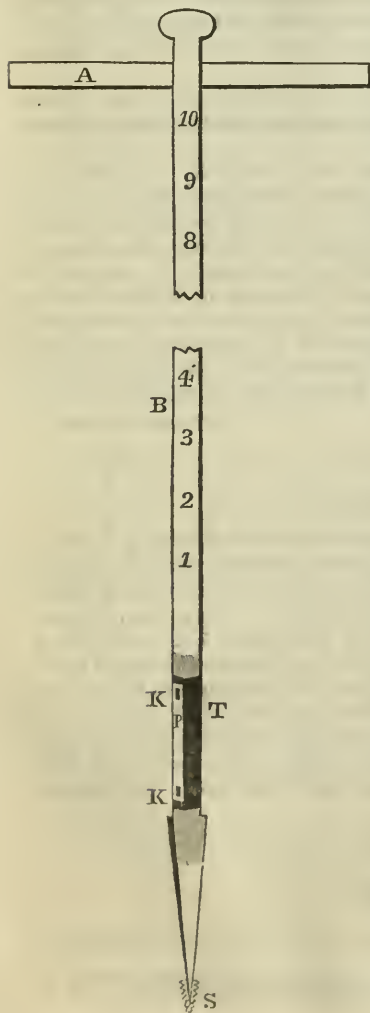
\* Expériences sur les Roues Hydrauliques a arbre vertical appelée turbine, par Arthur Morin, Capitaine d'Artillerie, &c. &c., Metz.

bed, or *strata*, and a *measure*; it is therefore intended for the purpose of ascertaining the depth of soft mineral, or earthy, strata.

*Explanation.*—A, a cross piece for working the instrument; B, a strong pole graduated to feet, &c. for fixing to T a stout iron tube with an opening equivalent to one-third the circumference as shown at P. P, an inner tube to work freely upon the interior of T, of similar shape. K, K, projections for opening and shutting the instrument; S, a suitable screw for working the instrument into the ground.

A simple and efficient instrument for this purpose has long been a desideratum. If a landed proprietor or surveyor is desirous of ascertaining the nature of the subsoil of an estate, or an engineer the subsoil of the bed of a river (as in the case of the Thames Tunnel,) with the means generally em-

ployed for such purposes, it becomes an operation of considerable time, trouble and expense. The landed proprietor or surveyor, goes to work by taking with him one or two men with pick, shovel, &c., who commence operations (perhaps in the centre of a fine meadow) by digging an unsightly pit some three or four feet square, and so reach the required depths. The engineer on the other hand, will, supposing him to go about the job *sans cérémonie*, in the method at present employed, bring with him augers, borers, &c., and by abstracting the earth by little and little, arrive at the required information. But with my instrument, the surveyor will soon accomplish his task. Throwing it over his shoulder as he would his gun, off he goes, and having fixed upon a spot, takes the cross piece, passes it through the hole at the top of the instrument, introduces the same into the ground, and works it down screw-fashion, from left to right, (the inner tube remaining shut.) After working it to the required depth, as indicated upon the stalk of the instrument, the motion is reversed, when the resistance of the projections upon the inner tube to the surrounding earth will cause the instrument to open and to charge itself with the soil at such depth. The motion being again reversed, will cause the tube to close; when the instrument, being withdrawn, will be found to contain, pure unmixed soil, taken from the required depth, that is, the soil through which the tube was passing, when the motion of the instrument was reversed.



Trusting that this invention will be of considerable utility,

I am, yours, &c.

WM. JONES.

Manchester, Dec. 16, 1839.

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*Analysis of a piece of iron converted, by the action of Sea water, into a substance resembling Plumbago.* By D. MUSHET.

In this communication Mr. Mushet gives the result of his analysis of a piece of the iron heel-post of a vessel, called the *John Bull*, which, by the effect of salt water, was converted into a substance resembling plumbago. This substance was of a dark brown color, and easily cut by a knife; on being exposed to a red heat, in a crucible, it lost about 20 per cent. in weight, and on being exposed to a white heat for four hours, it lost about 30 per cent. and came out a light mass of very brilliant carburet. This shining carburet was then used as a carbonaceous substance for the reduction of an oxide of iron, but was less efficacious than the same quantity of the charcoal of wood. From these and other experiments, Mr. Mushet considers 100 parts to be composed as follows:—

|                             |      |
|-----------------------------|------|
| Carbonic Acid and Moisture, | 20   |
| Protoxyde of Iron, -        | 35.7 |
| Silt, or earthy matter, -   | 7.2  |
| Carbon, - - -               | 41.1 |

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### Progress of Civil Engineering.

*Report, by ANDREW URE, M.D., F.R.S., &c., upon the asphalte rocks of Val-de-Travers, Seyssel, Pyrimont, &c., and their application as a mastich, in foot-pavements, roofs, aqueducts, cisterns, &c.*

It is a very remarkable fact, in the history of the useful arts, that asphalte which was so generally employed as a solid and durable cement in the earliest constructions upon record, as in the walls of Babylon, should, for so many thousand years, have fallen well nigh into disuse among civilized nations. For there is certainly no class of mineral substance so well fitted as the bituminous, by their plasticity, fusibility, tenacity, adhesiveness to surfaces, impenetrability by water, and unchangeableness in the atmosphere, to enter into the composition of terraces, foot-pavements, roofs, and every kind of hydraulic work. Bitumen, combined with calcareous earth, forms a compact, semi-elastic solid, which is not liable to suffer injury by the greatest alternations of frost and thaw, which often disintegrate, in a few years, the hardest stones; nor can it be ground to dust and worn away by the attrition of the feet of men and animals, as sandstone, flags, and even blocks of granite are. An asphalte pavement, rightly tempered in tenacity, solidity, and elasticity, seems to be incapable of suffering abrasion in the most crowded thoroughfares; a fact exemplified of late in a few places in London, but much more extensively, and for a much longer time, in Paris.

The great Place de la Concorde, (formerly Place Louis Quinze) is covered with a beautiful mosaic pavement of asphalte; many of the promenades on the Boulevards, formerly so filthy in wet weather, are now covered with a thin bed of bituminous mastich; free alike from dust and mud, the foot



paths of the Pont Royal and Pont Carousel, and the areas of the great public slaughter houses, have been for several years paved in a similar manner, with perfect success. It is much to be regretted that the Asphalte Companies of London made the ill-judged, and nearly abortive, attempt to pave the carriage-way, near the east end of Oxford street, and especially at a moist season, most unpropitious to the laying of bituminous mastich. Being formed of blocks not more than three or four inches thick, many of which contained much silicious sand, such a pavement could not possibly resist the crash and vibration of many thousand heavy drays, wagons, and omnibuses daily rolling over it. This failure can afford, however, no argument against rightly constructed foot-pavements and terraces of asphalte. Numerous experiments and observations have led me to conclude that fossil bitumen possesses far more valuable properties for making a durable mastich, than the solid pitch obtained by boiling wood or coal tar. The latter, when inspissated to a proper degree of hardness, becomes brittle, and may be readily crushed into powder, while the former, in like circumstances, retains sufficient tenacity to resist abrasion. Factitious tar and pitch being generated by the force of fire, seem to have a propensity to decompose by the joint agency of water and air, whereas mineral pitch has been known to remain for ages without alteration.

Bitumen alone is not so well adapted for making a substantial mastich, as the native compound of bitumen and calcareous earth, which has been properly called ASPHALTIC ROCK, of which the richest and most extensive mine is unquestionably that of the *Val-de-Travers*, in the Canton of Neuchâtel. This interesting mineral deposit occurs in the Jurassic limestone formation, the equivalent of the English oolite. The mine is very accessible, and may be readily excavated by blasting with gunpowder. The stone is massive, of irregular fracture, of a liver-brown colour, and is interspersed with a few minute spangles of calcareous spar. Though it may be scratched with the nail, it is difficult to break by the hammer. When exposed to a very moderate heat, it exhales a fragrant ambrosial smell, a property which at once distinguishes it from all compounds of factitious bitumen. Its specific gravity is 2114, water being 1000, being nearly the density of bricks. It may be most conveniently analyzed by digesting it in successive portions of hot oil of turpentine, whereby it affords 80 parts of a white pulverulent carbonate of lime, and 20 parts of bitumen in 100. The asphalte rock of Val-de-Travers seems, therefore, to be far richer than that of Pyrmont, which, according to the statement in the specification of Claridge's patent, of November, 1837, contains "carbonate of lime and bitumen in about the proportion of 90 parts of carbonate of lime to about 10 parts of bitumen."

The calcareous matter is so intimately combined and penetrated with the bitumen, as to resist the action not only of air and water for any length of time, but even of muriatic acid; a circumstance partly due to the total absence of moisture in the mineral, but chiefly to the vast incumbent pressure under which the two materials have been incorporated in the bowels of the earth. It would indeed be a difficult matter to combine, by artificial methods, calcareous earth thus intimately with bitumen, and for this reason the mastichs made in this way are found to be much more perishable. Many of the factitious asphalte cements contain a considerable quantity of silicious sand, from which they derive the property of cracking and crumbling down when trodden upon. In fact, there seems to be so little attraction between

silicious matter and bitumen, that their parts separate from each other by a very small disruptive force.

Since the asphalte rock of Val-de-Travers is naturally rich enough in concrete bitumen, it may be converted into a plastic workable mastich of excellent quality for foot-pavements and hydraulic works at very little expense, merely by the addition of a very small quantity of mineral, or coal tar, amounting to not more than six or eight per cent. The union between these materials may be effected in an iron caldron, by the application of a very moderate heat, as the asphalte bitumen readily coalesces with the tar into a tenacious solid.

The mode adopted for making the beautiful asphalte pavement at the Place de la Concorde in Paris was as follows:—The ground was made uniformly smooth, either in a horizontal plane, or with a gentle slope to carry off the water; the curb-stones were then laid round the margin by the mason, about four inches above the level of the ground. This hollow space was filled to a depth of three inches with concrete, containing about a sixth part of hydraulic lime, well pressed upon its bed. The surface was next smoothed with a thin coat of mortar. When the whole mass had become perfectly dry, the mosaic pattern was set out on the surface, the moulds being formed of flat iron bars, rings, &c., about half an inch thick, into which the fluid mastich was poured by ladles from a caldron, and spread evenly over.

The mastich was made in the following way:—The asphalte rock was first of all roasted in an oven, about ten feet long and three broad, in order to render it friable. The bottom of the oven was sheet iron, heated below by a brisk fire. A volatile matter exhaled, probably of the nature of naphtha, to the amount of one-fortieth the weight of asphalte; after roasting, the asphalte became so friable as to be easily reduced to powder and passed through a sieve, having meshes about one-fourth of an inch square.

The bitumen destined to render the asphalte fusible and plastic, was melted in small quantities at a time, in an iron caldron, and then the asphalte in powder was gradually stirred in to the amount of twelve or thirteen times the weight of bitumen. When the mixture became fluid, nearly a bucketful of very small, clean gravel, previously heated apart, was stirred into it; and as soon as the whole began to simmer with a treacley consistency, it was fit for use. It was transported in buckets, and poured into the moulds.

For the reasons above assigned, I consider this addition of rounded, polished, silicious stones to be very injudicious. If any thing of the kind be wanted to give solidity to the pavement, it should be a granitic, or hard, calcareous sand, whose angular form will secure the cohesion of the mass. I conceive, also, that tar, in moderate quantity, should be used to give toughness to the asphaltic combination, and prevent its being pulverized and abraded by friction.

In the able report of the Bastenne and Gaujac Bitumen Company, drawn up by Messrs. Goldsmid and Russel, these gentlemen have made an interesting comparison between the properties of mineral tar and vegetable tar: the bitumen composed of the latter substance, including various modifications extracted from coal and gas, have, so far as they were able to ascertain, entirely failed. This bitumen, owing to the qualities and defects of vegetable tar, becomes soft at 115° of Fahrenheit's scale, and is brittle at the freezing point; while the bitumen, into which mineral tar enters, will sustain 170° of heat, without injury. In the course of the winter, 1837–38, when the cold was at 14½° below Zero, the bitumen of Bastenne and Gau-

jac, with which one side of the Pont Neuf at Paris is paved, was not at all impaired, and would, apparently, have resisted any degree of cold; while that in some parts of the Boulevard, which was composed of vegetable tar, cracked and opened in wide fissures. The French Government, instructed by these experiments, has required, when any of the vegetable bitumens are laid, that the pavement should be an inch and a quarter thick; whereas, where the bitumen composed of mineral tar is used, a thickness of three quarters of an inch is deemed sufficient. The pavement of the bonding-warehouse at Bordeaux, has been laid upwards of fifteen years by the Bastenne Company, and is now in a condition as perfect as when first formed. The reservoirs constructed to contain the waters of the Seine at Batignolles, near Paris, have been mounted six years, and notwithstanding the intense cold of the winter of 1837, which froze the whole of their contents into one solid mass, and the perpetual water pressure to which they are exposed, they have not betrayed the slightest imperfection in any point. The repairs done to the ancient fortifications at Bayonne, have answered so well, that the Government, two years ago, entered into a very large contract with the company for additional works, while the whole of the arches of the St. Germain and St. Cloud Railways, and the pavements and floorings necessary for these works, are being laid with the Bastenne bitumen.

The mineral tar in the mines of Bastenne and Gaujac is easily separated from the earthy matter with which it is naturally mixed, by the process of boiling, and is then transported in barrels to Paris or London, being laid down in the latter place to the company at 17*l.* per ton, in virtue of a monopoly of the article purchased by the company at a sum, it is said, of 8000*l.*

Mr. Harvey, the able superintendent of the Bastenne Company, was good enough to supply me with various samples of mineral tar, bitumen, and asphaltic rock for analysis. The tar of Bastenne is an exceedingly viscid mass, without any earthy impurity. It has the consistence of baker's dough, at 60° of Fahrenheit; at 80° it yields to the slightest pressure of the finger; at 150° it resembles a soft extract, and at 212° it has the fluidity of molasses. It is admirably adapted to give plasticity to the calcareous asphaltes.

A specimen of Egyptian asphalte which he brought me, gave, by analysis, the very same composition as the Val-de-Travers, namely, 80 per cent. of pure carbonate of lime, and 20 of bitumen. A specimen of mastich, prepared in France, was found to consist, in 100 parts, of 29 of bitumen, 52 of carbonate of lime, and 19 of silicious sand. A portion of stone called the natural Bastenne rock, afforded me 80 parts of gritty silicious matter, and 20 of thick tar. The Trinidad bitumen contains a considerable portion of foreign earthy matter; one specimen having yielded me 25 per cent. of silicious sand; a second, 28; a third 20; and a fourth, 30: the remainder was pure pitch. One specimen of Egyptian bitumen, specific gravity 1.2 was found to be perfectly pure, for it dissolved in oil of turpentine without leaving any appreciable residuum.

Robinson's Parisian Bitumen Company, use a mastich made with the pitch obtained from boiling coal tar mixed with chalk. One piece laid down by this company at Knightsbridge and another at Brighton, are said to have gone to pieces. The portion of pavement laid down by them in Oxford street, next Charles street, has been taken up. Claridge's Company have laid down their mastich under the archway of the Horse-Guards, and in the carriage entrance at the Ordnance-office; the latter has cracked at the



junction with the old pavement of Yorkshire curb stone. The foot-pavement laid down by Claridge's company at Whitehall, has stood well. The Bastenne Company has exhibited the best specimen of asphaltic pavement in Oxford street; they have laid down an excellent piece of foot pavement, near Northumberland house; a piece, 40 feet by seven, on Blackfriars-bridge; they have made a substantial job in paving 830 superficial feet, in front of the Guard-room at Woolwich, which though much traversed by foot passengers, and beat by the guard in grounding arms, remains sound; lastly, the floor of the stalls belonging to the cavalry barracks of the Blues at Knightsbridge, is probably the best example of Asphaltic pavement laid down in this country, as it has received no injury from the beating of the horses' feet.

As the specific gravity of properly made mastich, is nearly double that of water, a cubic foot of it will weigh from 125 to 130 lbs.; and a square foot three quarters of an inch thick, will weigh very near eight pounds. A ton of it will, therefore, cover 280 square feet. The prices at which the Bastenne Bitumen Company sell their products, is as follows:—

Pure mineral tar, £24 per ton, or 28s. per cwt.

Mastich, 8 8s. 10 "

| SIDE PAVEMENT. |       |           |                   | ROOFS AND TERRACES. |    |
|----------------|-------|-----------|-------------------|---------------------|----|
| From           | 50 to | 100 feet, | 1s. 3d. per foot, | 1s. 6d. per foot.   |    |
|                | 100   | 250       | 1 1               | 1                   | 4  |
|                | 250   | 500       | 0 11              | 1                   | 1  |
|                | 200   | 750       | 0 10              | 1                   | 0  |
|                | 750   | 1000      | 0 9               | 0                   | 11 |
|                | 1000  | 2000      | 0 8               | 0                   | 10 |
|                | 2000  | 5000      | 0 7               | 0                   | 9  |

Where the work exceeds 5000 feet, contracts may be entered into.

For filling up joints of brickwork, &c., from 1d. to 1½d. per foot, run according to quantity.

These prices are calculated for half an inch thickness, at which rate a ton will cover 420 square feet.

As the Val-de-Travers Company engage to lay down their rich asphaltic rock in London at 5*l*. per ton, and as a mineral tar equal to that of Seissel may probably be had in England, at one-fourth of the price of the foreign article, they may afford to lay their mastich three-quarters of an inch thick, per the thousand feet, including a substratum of concrete, at a rate of five-pence a square foot, instead of fifteenpence, being the rate charged under that condition, by the Bastenne Company.

These charges are for London and its immediate vicinity.

13, Charlotte street, Bedford Square, April 22nd, 1829.

Min. Jour.

*Description of the Hypsometer, an Instrument invented by JOHN SANG, Esq., Land Surveyor, for taking the Heights of Trees, Buildings, and other objects. Communicated by MR. SANG, Land Surveyor, Kirkcaldy.*

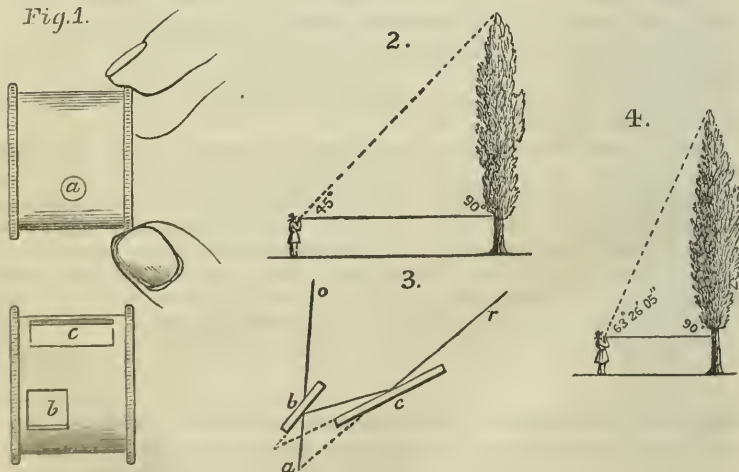
I have taken the first leisure hour to make you the instrument for measuring the height of trees and buildings which I mentioned to you when having the pleasure of visiting you at Bayswater. It is sent by post at the same time as this letter.

The instrument was tried on some houses and trees here, and it gave their height (especially the houses) with great accuracy. It is rather dif-

difficult to manage at first, but after a few trials it becomes quite easy. The method is as follows:—

By means of a small hook (if a knot of white cloth be attached to it, so much the better), fix the end of a tape line to the bole of the tree, at exactly the height of the observer's eye from the ground. Retire from the tree, letting the tape line unwind until, by using the instrument, the top of the tree and the end of the tape line are seen quite close together. Add the height of the observer's eye to the length of the tape line, and the sum is the height of the tree. Now, the difficulty is, to catch the image of the top of the tree in the instrument, and it is this which requires a few trials, although any person who has been accustomed to use a sextant will do it at the very first. Hold the instrument by one of the milled ends, taking care that the fingers do not project over any of the holes, and that the brim of the hat is out of the way. Apply the eye to the round hole marked *a* in fig. 1, and look through in the direction of the small square hole *b*, the instrument being held so that the line joining *a b* is about level, while the large square hole *c* is turned towards the sky. You will then see some object directly through the small hole, and at the same time the image of some other object, the light from which enters the large aperture, and, after being reflected by the two mirrors inside, passes into the eye. Whatever two objects are thus seen in contact, subtend at the eye an angle of  $45^\circ$ , as in fig. 2; so that, if one of them be the end of the tape line on a level, or nearly so, with the observer's eye, while the other is the top of a tree, supposed to be growing straight up, the distance from the eye to the bole of the tree will be exactly equal to the distance from the end of the tape line to the top of the tree.

Fig. 1.



You will thus observe that the accuracy of the measurement depends on the tree being erect from the ground. On sloping ground the measurer would require to go out from the tree in such a direction that the tape line was perpendicular to the stem, but this could be judged sufficiently well by the eye to give the height, of even a very high tree, nearly correctly. The heights of those houses I tried were given within an inch, which was no doubt owing to their being perfectly upright on a level court yard.

The principle of the instrument is quite simple, being exactly the same as that of the sextant or quadrant, only that the mirrors are fixed at a certain angle instead of being movable. Thus, in fig. 3, *a* is the eye, *b* a mirror partly silvered, and *c* a larger mirror wholly silvered. A ray of light *r*, falling on the mirror *c*, is reflected from it in the direction *c b*, and again reflected from the mirror *b* in the direction *b a* to the eye; at the same time another ray of light comes from an object *o* direct to the eye at *a*, without being reflected. From the nature of reflected light, the angle  $\angle r a o$  is equal to twice the inclination of the mirrors, and is constant, however much the whole instrument may be moved in the plane of the objects, as you will easily perceive by catching the reflection of the candle in the instrument, and moving it in the plane of the milled ends.

I am sure this very portable instrument will be useful for measuring single trees, or buildings, which are as far asunder as they are high, but I am afraid it will not work well in a close wood, on account of the operator not having room to retire as far from the trees as their height. If this is found to be the case, the remedy is to construct another instrument in which the mirrors are placed so as to give an angle of  $63^{\circ} 26' 05''$ . In this case the height of the trees will be equal to twice the length of the tape, added to the height of the observer's eye. (See fig. 4.) Of course a small deviation from squareness in the trees and tape line will make a greater error than with the instrument sent, but still it will give a result near enough for all practical purposes.

I have only to add, that the mirrors are made of common window glass selected as the most even from among a great many pieces, but still they are not quite flat. I had some glass from London perfectly true and flat, but so dim and badly polished as to be unfit for use.

Kirkcaldy, Jan. 31, 1840.

Gardeners' Mag.

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*Postscript in Answer to some Questions asked of Mr. Sang by the Conductor.*

The instrument for measuring the height of trees is not a pocket sextant, like that of Mr. Blackadder, mentioned in vol. xiv. p. 257, although nearly allied to it. The sextant, quadrant, reflecting circle, improved Wollaston's goniometer, as well as the optical square and tree-measurer, are all varieties or improvements on Hadley's first invention. The two latter differ from the rest in the mirrors being permanently fixed at angles suitable for the purposes for which they were intended. The pocket sextant would measure the height of trees quite as well, but, being expensive, and requiring some skill to use it, it is not likely to be much employed for such purposes. There is no sort of merit in designing the instrument; and it so exceedingly simple, that I have no doubt the idea of modifying the sextant, so as to make it readily measure the height of trees, has occurred to many a one. I, however, never heard of such an instrument, and believe that the one you have is the second of its kind in existence. The other is one which was made for yourself. My father was so much pleased with it that he asked me to make one for him, which turned out neater than the first, and accordingly I sent it to you, as being the better of the two. As there is nothing like a Greek name for giving identity to it, you might call it a dendrometer, or, better still, a hypsometer (measure of height).

Of course any instrument maker could supply these articles; the price, I should think, would be about 20s. each. If there were any prospect of sell-



ing a dozen or two, I could easily employ a workman here to make them, and they might be sent from the seedshop to any place by post.

Kirkcaldy, Feb. 18, 1840.

Gardner's Mag.

*Description of a Polyphotal Lamp, and Reflector of Single Curvature, employed in Steam Vessels, Canal Boats, &c. By JOHN SCOTT RUSSEL, A. M., F. R. S. E., V. P. S. A.\**

Several years ago I was applied to by Mr. Ellis, the Secretary of the Union Canal, to assist in some contrivances for expediting canal transport, and adding to its security. Amongst other things, this lamp and reflector resulted from this application. It has been in constant use ever since; it is now used also on the Forth and Clyde Canal, and is about to be introduced in steam vessels. It is also capable of being used with advantage in many other situations, where concentration is not required.

The view with which this lamp was constructed was that of throwing light forward before the boat upon all the objects in a certain range, and to a great distance, so as to illuminate the banks of the canal, to throw light upon any vessel coming in the opposite direction,—to throw a light on the horse's path and on the arches of the bridges, so that the horses, their rider, and the helmsman, might clearly see and avoid them. All this the lamp has, for four or five years been successfully accomplishing. It is, besides, not expensive, and is kept in order by the common boatmen without difficulty.

The lamp is polyphotal, or allows several lights or burners to be used simultaneously in the same reflector. The reflector being of single curvature, is easily made, and at little expense.

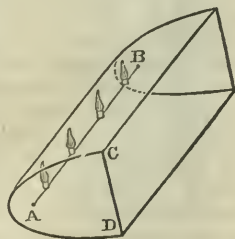
The construction of the reflector may be easily understood by conceiving a thin sheet of silver, strengthened by being united to a copper plate, to be bent round in the middle, so as to coincide with a parabola, and form a species of conoid or surface, whose section, at right angles to the plane of the parabola, is rectilinal.

In the focal transverse axis of this figure, that is in the line joining the foci of the parabolas, at the two ends of this figure, are placed any number of lights, as in the lamp exhibited.

The figure which is thus formed has this property, that a plane vertical section through any point in the transverse focal axis A B, is a parabola whose focal distance varies with the angle of divergence. The new focus may be found by the formula:  $f^1 = f^2 \cos \theta$ ,  $f$  being the direct focus of the primary parabola, and  $f^1$  the focus of the parabola inclined at the angle  $\theta$ .

For the divergent rays, therefore, it follows that, so long as the radius of the flame does not exceed the difference between  $f$  and  $f^1$  in the formula, the parallelism of the rays in a vertical plane will be perfect for a certain part of the flame.

I have taken, of course, for granted, as in the case before us, that lateral divergence is wanted, and that vertical divergence alone would be consider-

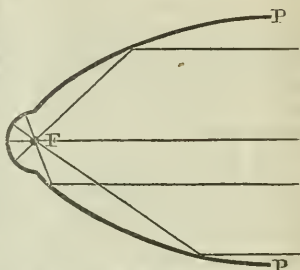


\* Read before the Society of Arts for Scotland, November 13, 1839.

ed a loss; or, in other words, that light is wanted to spread forwards, on both sides, but not upwards or downwards.

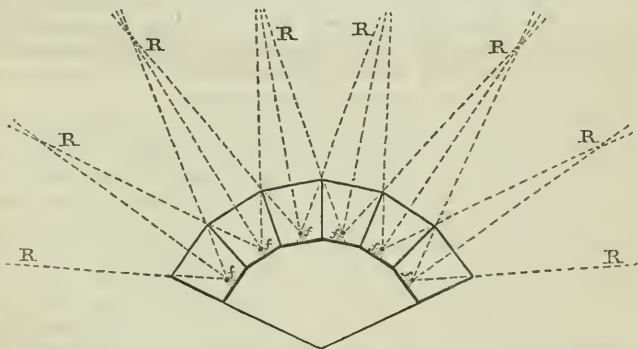
The ends of the lamp are formed in the same way as the top and bottom, but this is perhaps unnecessary where horizontal divergence is of no consequence, as they might be plain surfaces without much loss.

It is of consequence, in the case of the lamp exhibited, to have the focus of the reflector short; this would bring the burners too close to the back, and as light is required for dispersion in the vicinity, the back is cylindrical, and concentric with the transverse focal axis *A B*. The effect of this is seen in the annexed diagram, where *F* is the focus of the parabola and the centre of the attached semicircle, whose radius is equal to the semiparameter.



The use of such a lamp in a steam-vessel, is to show an object a-head of the vessel, and to assist them in navigating narrow channels or rivers at night. The canal boats go now with these lamps, in a dark night, at the rate of ten miles an hour, as safely as in the day.

The same principle is applicable to a pier-light, or a directing light, which extends through a part only of the horizon, so as to render lenses inapplicable. This arrangement is shown in the following drawing:—



The lines *fR*, *fR*, &c., give the rays divergent in every direction horizontally, and only rendered parallel in the vertical planes, through each of the foci *fff*. The zone of light would thus be complete in every direction, without the dark intervals produced by reflectors of double curvature, which only emit one large parallel beam.

It is, however, to be remembered that, when it is required to carry a parallel beam of light only in a single direction, and to a great distance, this species of reflector and lamp can be of no service, its use being to carry forward a powerful light over a horizontal angle of considerable extent.

Edinburgh New Philosophical Journal.

NOTICE FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL  
OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

*On a sounding or boring executed at Cessingen, in the Grand Duchy of  
Luxemburg.*

(Extract of a letter from M. Levallois, Engineer in Chief of Mines.)

They are at this moment at work at a sounding, at the village of Cessingen, about a league from Luxemburg, which deserves particular notice. On the first of April 1839, they had attained the depth of 534 metres (= 1752 feet) the greatest, certainly, which has been reached in Europe, up to the present time.

The object of this enterprise, is rock salt. The undertaker is M. Rost, a skilful Saxon engineer, on account of a company, in which the most notable financiers of Brussels are interested. It was commenced on the first of February, 1837, and they are now advancing at the rate of a metre in twenty-four hours. To proceed successfully, at a depth hitherto unattained, requires a directing intelligence, capable of surmounting obstacles which continually present themselves in works of this nature, especially when I add, that it is done by a *stem* borer, and that the stem, or rod, is but three-fourths of an inch in thickness. It belongs to M. Rost to explain, in detail, the various inventions which he has devised, but I wish to give an idea of what he calls his parachute, because to this he attributes, in a great degree, the successful progress of his boring.

It is well known that upon the sounding rod, if a borer breaks, which is often the case, the unsupported portion of it in falling, is broken by the shock, into several fragments, which become so wedged together in the hole as to render their abstraction very troublesome. To prevent such an effect from the fall, M. Rost contrived his parachute.

This additional piece is attached to the lower part of the rod, which is there strengthened for the purpose, so as to be certain that the fracture will not occur at that place. It consists of a wooden sleeve or muff, through which the rod can freely play through a space rather greater than the leap, or stroke of the sound. Below this muff, are attached by iron bolts several targets of superimposed leather, of a diameter just equal to that of the hole which is thus, as it were, stoppered by a kind of piston. Now, when the stem breaks, the upper part can fall only through a space equal to the play of the borer through the muff, and when the stop which limits this play strikes the head of this piece, it can only descend very slowly, in consequence of the friction of the leather against the sides of the hole.

M. Rost has also diminished the frequency of ruptures, by making the first three-sevenths of his rod of wood four inches square.

The hole is tubed, four tubes having been introduced of decreasing diameters. M. Rost does not shrink at the idea of carrying his boring to the depth of 700 metres, or 2300 feet.

| The beds already traversed are,                            | Metres. |
|------------------------------------------------------------|---------|
| Calcareous rock-lias, . . . . .                            | 62.00   |
| Luxemburg free stone, . . . . .                            | 83.57   |
| Greyish sandy marl, . . . . .                              | 25.43   |
| Upper Kuperin marl; with gypsum and saline clay, . . . . . | 166.00  |
| Stuttgart free stone, . . . . .                            | 8.90    |
| Lower Kuperin marl; with gypsum and saline clay, . . . . . | 188.10  |

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534.00



*Observations on the influence of rarefaction upon the moisture contained in Air.* BY PROF. R. HARE.

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN,—The fact that air saturated with water (but not in contact with it in a liquid state) when rarefied, indicates great dessicating power, led me, at the conversation meeting in May, to express doubts of the correctness of an opinion, which I had previously sanctioned in my text book, that the transient cloud observed in a receiver, subjected to exhaustion, arises from water in the aeriform state. Having lately rarefied air to one half of its previous density, and subsequently subjected the containing vessel to a freezing mixture, until a thermometer in the axis of the vessel was three degrees below freezing, I found the hygrometer to indicate dampness about ten degrees beyond the point at which it had stood at the beginning of the process; and at the same time a deposition of moisture took place. Agreeably to Dalton's tables I find that under these circumstances about two-fifths of the vapours should be condensed, and by calculation about twenty-five degrees of heat should be imparted to the surrounding air.

It follows that the condensing influence of a freezing temperature is paramount to the dessicating influence of a reduction of density to one half of that of the atmosphere; also that in passing from the neighbourhood of the terrestrial surface to an elevation of three miles, clouds will be formed in moist air previously at seventy degrees, by a cold near the freezing point, in consequence of the condensation of aqueous vapour: the caloric previously in the vapour being transferred to the air and causing a commensurate expansion.

In an essay, published in Silliman's Journal in 1822, I had made the inference that in passing from the state of vapour to that of snow, water would impart to the air as much heat as would be yielded by twice its weight of red hot powdered glass. I must grant to Mr. Espy the merit of pointing out the probable influence of the caloric thus evolved in increasing the comparative buoyancy of the air. I cannot, however, concur with him in the opinion that any buoyancy thus created would be adequate to produce a tornado or a hurricane, or that electricity is not a principal agent in the production of storms, clouds, rain, and snow.

In the translation of the moisture and air of the Atlantic, or of the Gulf of Mexico, to the sky of the United States, as in our northeastern or southeastern gales, I infer that the source of expansion to which he has drawn attention, may be a principal agent.

Yours sincerely,  
ROBERT HARE.

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ERRATA.

Page 164, line 10 from bottom, for "*water*" read "*matter*."

165, " 27 " " for "*unprobable*" read "*improbable*."

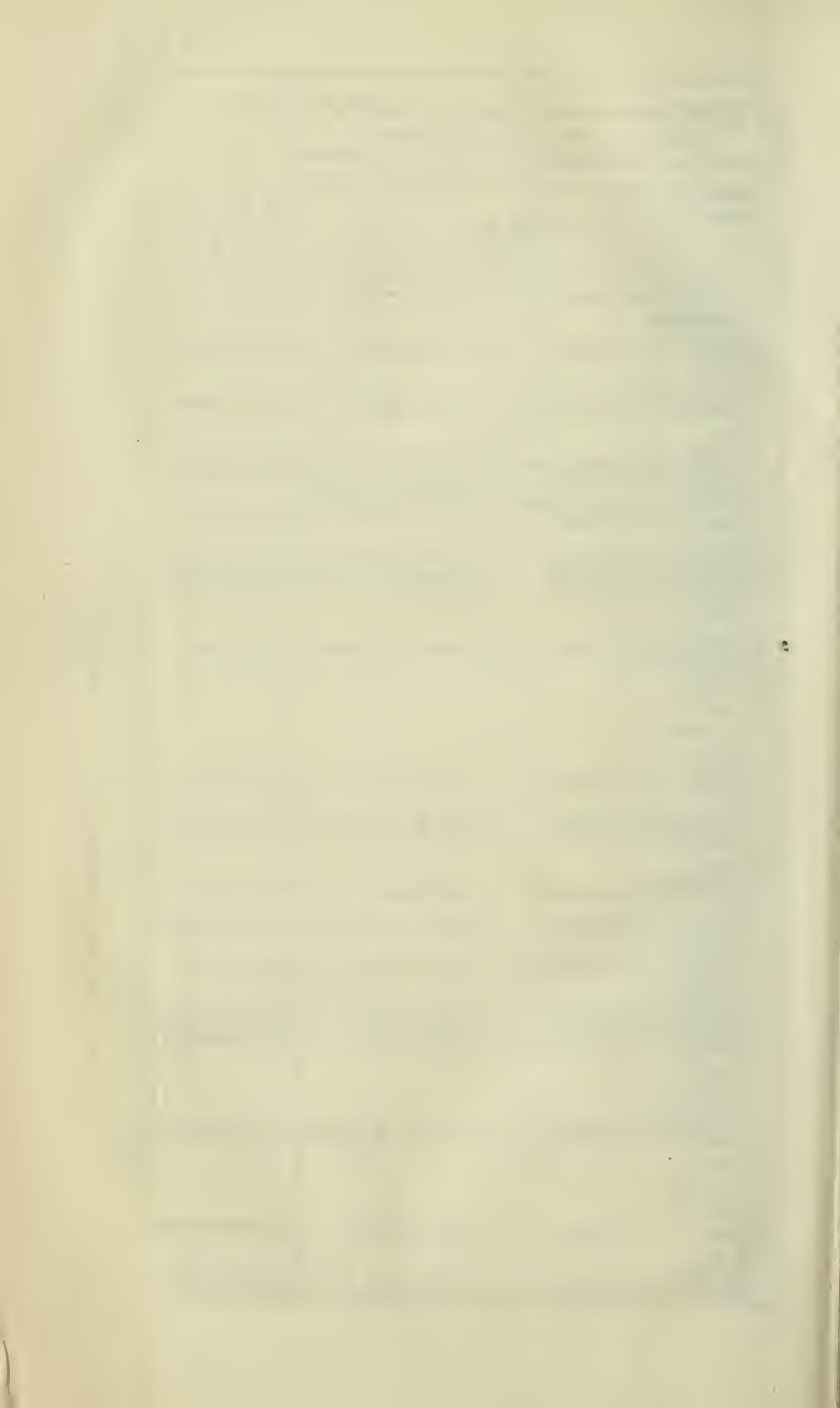
| LUNAR OCCULTATIONS FOR PHILADELPHIA,<br>AUGUST, 1840. |      |      |                                      |      | Angles reckoned to the right or<br>westward round the circle, as seen<br>in an inverting telescope.<br>☞ For direct vision add 180° ☜ |                        |
|-------------------------------------------------------|------|------|--------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Day.                                                  | H'r. | Min. | Star's name.                         | Mag. | From Moon's<br>North point.                                                                                                           | From Moon's<br>Vertex. |
| 8                                                     | 10   | 57   | Im. (359) Sagittarii,                | 5    | 158°                                                                                                                                  | 134°                   |
| 8                                                     | 11   | 43   | Em.                                  |      | 225                                                                                                                                   | 248                    |
| 12                                                    | 16   | 44   | Im. d <sup>2</sup> Capricorni,       | 6    | 202                                                                                                                                   | 248                    |
| 12                                                    | 16   | 56   | Em.                                  |      | 224                                                                                                                                   | 271                    |
| 12                                                    | 16   | 27   | Im. d <sup>3</sup> Capricorni,       | 6    | 81                                                                                                                                    | 126                    |
| 12                                                    | 17   | 13   | Em.                                  |      | 343                                                                                                                                   | 31                     |
| 19                                                    | 14   | 20   | N. App. ♃ and 7 Tauri. 6 ♃ South 1.1 |      |                                                                                                                                       |                        |

### Meteorological Observations for March, 1840.

| Moon.                            | Days | Therm.       |           | Barometer.   |           | Wind.          |            | Water<br>fallen in<br>rain. | State of the weather, and<br>Remarks. |
|----------------------------------|------|--------------|-----------|--------------|-----------|----------------|------------|-----------------------------|---------------------------------------|
|                                  |      | Sun<br>rise. | 2<br>P.M. | Sun<br>ries. | 2<br>P.M. | Direction.     | Force.     |                             |                                       |
|                                  |      |              |           | Inch's       | Inch's    |                |            | Inches.                     |                                       |
|                                  | 1    | 42           | 56        | 29.90        | 29.90     | S.             | Calm.      | .10                         | Cloudy—showery.                       |
| ⊗                                | 2    | 39           | 66        | 30.10        | .90       | S.W.           | do.        |                             | Cloudy—hazy.                          |
|                                  | 3    | 51           | 65        | 29.85        | .80       | E.S.           | do.        |                             | Cloudy—do.                            |
|                                  | 4    | 54           | 72        | .65          | .50       | S.W.           | Brisk.     |                             | Hazy—clear.                           |
|                                  | 5    | 45           | 57        | .50          | .50       | N.W.           | do.        |                             | Clear—do.—Aurora.                     |
|                                  | 6    | 34           | 53        | .65          | .50       | W.             | do.        |                             | Clear—do.                             |
|                                  | 7    | 39           | 54        | .55          | .50       | W.             | do.        |                             | Clear—do.                             |
|                                  | 8    | 21           | 40        | .85          | .80       | N.W.           | Moderate.  |                             | Clear—do.                             |
|                                  | 9    | 34           | 56        | .40          | .35       | S.W.           | Brisk.     |                             | Cloudy—clear.                         |
| ☾                                | 10   | 36           | 62        | .35          | .35       | S.W.           | do.        | .6                          | Clear—flying clouds—snow.             |
|                                  | 11   | 13           | 32        | .70          | .80       | N.W.           | do.        |                             | Clear—do.                             |
|                                  | 12   | 23           | 40        | .95          | .90       | N.W.           | do.        |                             | Cloudy—do.                            |
|                                  | 13   | 30           | 38        | .75          | .85       | N.W.           | do.        |                             | Cloudy—flying clouds.                 |
|                                  | 14   | 23           | 47        | 30.16        | 30.20     | W.             | do.        |                             | Clear—do.                             |
|                                  | 15   | 33           | 42        | 29.90        | 29.74     | E.             | Moderate.  | .1                          | Snow—cloudy.                          |
| ☼                                | 16   | 37           | 52        | .70          | .75       | W.             | do.        |                             | Flying clouds—do. do.                 |
|                                  | 17   | 42           | 42        | .50          | .50       | E.             | do.        | .24                         | Rain—cloudy.                          |
|                                  | 18   | 34           | 54        | .85          | .90       | N.S.E.         | do.        |                             | Cloudy—do.                            |
|                                  | 19   | 40           | 44        | .80          | .85       | E.             | do.        | .19                         | Cloudy—rain.                          |
|                                  | 20   | 42           | 49        | .85          | .95       | N.E.           | do.        |                             | Cloudy—do.                            |
|                                  | 21   | 41           | 48        | 30.03        | 30.00     | N.W.           | do.        |                             | Cloudy—flying clouds.                 |
|                                  | 22   | 27           | 38        | .23          | .23       | N.W.           | do.        |                             | Clear—do.                             |
|                                  | 23   | 32           | 46        | .10          | .00       | S.W.           | do.        |                             | Partially cloudy—do.                  |
|                                  | 24   | 36           | 39        | 29.65        | 29.32     | E.             | Blustering | .70                         | Rain—snow.                            |
| ☾                                | 25   | 27           | 34        | .40          | .43       | N.             | Moderate.  |                             | Cloudy—do.                            |
|                                  | 26   | 26           | 42        | .60          | .60       | N.W.           | do.        |                             | Clear—do.                             |
|                                  | 27   | 37           | 59        | .83          | .85       | N.             | Brisk.     |                             | Cloudy—clear.                         |
|                                  | 28   | 48           | 55        | .90          | .93       | S.W.           | Moderate.  |                             | Cloudy—do.                            |
|                                  | 29   | 51           | 73        | .89          | .80       | S.W.           | do.        |                             | Cloudy—showery.                       |
|                                  | 30   | 51           | 65        | .60          | .40       | E.             | Brisk.     | .60                         | Rain—cloudy.                          |
|                                  | 31   | 36           | 50        | .70          | .70       | W.             | do.        |                             | Clear—flying clouds.                  |
|                                  | Mean | 36.81        | 51.45     | 29.77        | 29.74     |                |            | 1.94                        |                                       |
|                                  |      |              |           |              |           | Thermometer.   |            | Barometer.                  |                                       |
| Maximum height during the month. |      |              |           |              |           | 73.00 on 29th. |            | 30.23 on the 22nd.          |                                       |
| Minimum " " "                    |      |              |           |              |           | 18.00 on 11th. |            | 29.32 " 24th.               |                                       |
| Mean                             |      |              |           |              |           | 44.13          |            | 29.755                      |                                       |

| METEOROLOGICAL REPORT<br>FOR THE STATE OF PENNSYLVANIA,<br>Collected from returns made to the Committee on Meteorology<br>of the Franklin Institute of the State of Pennsylvania, for<br>DECEMBER, 1899. |                 |                       | Thermometer. |          |          |          |          |       |               |         |       | Barometer.    |          |          |          |          | Weather. |       |               |        |         |               | Winds. |       |                |                  |                 |        |          |        |          |       |          |       | Hygrometer. |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------|--------------|----------|----------|----------|----------|-------|---------------|---------|-------|---------------|----------|----------|----------|----------|----------|-------|---------------|--------|---------|---------------|--------|-------|----------------|------------------|-----------------|--------|----------|--------|----------|-------|----------|-------|-------------|--------|----------|-------|----------|--------|----------|--------|----------|-------|---------------|------------|---------------|-----------------------------|-----------|---------------|----------------|
|                                                                                                                                                                                                          |                 |                       | 7. A. M.     | 8. P. M. | 9. P. M. | Maximum. | Minimum. | Mean. | Days omitted. | Lowest. | Mean. | Days omitted. | 7. A. M. | 8. P. M. | 9. P. M. | Maximum. | Minimum. | Mean. | Days omitted. | Clear. | Cloudy. | Days omitted. | Rain.  | Snow. | Rain and Snow. | Thunder Showers. | Rain in inches. | North. | N. N. E. | N. E.  | E. N. E. | East. | E. S. E. | S. E. | S. S. E.    | South. | S. S. W. | S. W. | W. S. W. | West.  | W. N. W. | N. W.  | N. N. W. | Calm. | Days omitted. | Dew-point. | Days omitted. | Diff. therm. and dew point. | Wet Bulb. | Days omitted. | No. of Report. |
| County.                                                                                                                                                                                                  | Town.           | Observer.             |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 1 Philadelphia.                                                                                                                                                                                          |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 2 Montgomery.                                                                                                                                                                                            |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 3 Bucks.                                                                                                                                                                                                 | Newtown.        | L. H. Parsons.        | 30.90        | 39.14    | 31.86    | 58.00    | 14.00    | 33.97 |               | 15.     | 26.58 |               | 29.84    | 29.84    | 29.86    | 30.50    | 28.90    | 29.85 |               | 8 1/2  | 22 1/2  |               |        |       |                |                  | 7.170           | 2      |          | 10 1/2 |          |       |          |       |             |        | 3        |       |          | 13 1/2 |          |        | 10 1/2   |       | 33.84         |            |               |                             |           |               | 911            |
| 4 Lehigh.                                                                                                                                                                                                |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 5 Northampton.                                                                                                                                                                                           |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 6 Monroe.                                                                                                                                                                                                | Stroudsburg.    | A. M. Stokes.         | 24.85        | 33.25    | 29.28    | 55.00    | 8.00     | 29.13 | 9 1/2         | .....   | ..... |               | 29.44    | 29.41    | 29.44    | 29.60    | 29.00    | 29.43 | 8             | 7      | 15      | 9             |        |       |                |                  |                 |        | 4        |        | 2 1/2    | 3     | 2 1/2    | 3     |             |        |          | 3 1/2 |          | 5 1/2  | 1        | 10 1/2 |          | ..... |               |            |               |                             |           | 908           |                |
| 7 Pike.                                                                                                                                                                                                  |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 8 Wayne.                                                                                                                                                                                                 | Silver Lake.    | E. W. Rose.           | 24.13        | 30.16    | 25.87    | 44.00    | 7.00     | 26.72 |               | 5.      | 20.68 |               | 27.76    | 27.79    | 27.73    | 28.10    | 26.90    | 27.76 |               | 7 1/2  | 23 1/2  |               | 1      | 11    |                |                  | 3.790           | 5 1/2  |          | 1 1/2  |          |       |          |       |             |        | 3        |       | 12       |        | 7        |        | .....    |       |               |            |               |                             | 921       |               |                |
| 9 Luzerne.                                                                                                                                                                                               | Wilkesbarre.    | Welding F. Demmie.    | 27.74        | 35.52    | 27.90    | 49.00    | 11.00    | 30.35 |               | .....   | ..... |               | 29.21    | 29.21    | 29.21    | 29.52    | 28.18    | 29.21 |               | 6 1/2  | 24 1/2  |               | 2      | 7     |                |                  | 1.995           | 4 1/2  |          | 2 1/2  |          |       |          |       |             |        | 1 1/2    |       | 16 1/2   |        | .....    |        |          |       |               |            | 916           |                             |           |               |                |
| 10 Schuylkill.                                                                                                                                                                                           | Port Carbon.    | Port Carbon Lyceum.   |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 11 Berks.                                                                                                                                                                                                | Reading.        | C. F. Egelmann.       | 30.00        | 34.71    | 32.00    | 55.00    | 19.00    | 32.24 |               | .....   | ..... |               | 29.69    | 29.63    | 29.65    | 30.00    | 28.70    | 29.66 |               | 7 1/2  | 23 1/2  |               | 4      | 5     | 1              |                  |                 | 2 1/2  |          | 3 1/2  |          | 3     |          |       |             |        |          | 1 1/2 | 3        | 17 1/2 |          | .....  |          |       |               |            |               | 902                         |           |               |                |
| 12 Chester.                                                                                                                                                                                              |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 13 Delaware.                                                                                                                                                                                             | Haverford.      | Haverford School.     | 30.28        | 36.54    | 32.00    | 56.00    | 17.00    | 32.94 | 2             | 18.     | 29.90 |               | 29.39    | 29.39    | 29.43    | 29.83    | 28.38    | 29.40 | 5 1/2         | 6      | 19 1/2  | 5 1/2         |        |       |                | 3.607            | 1 1/2           |        | 6 1/2    |        | 1 1/2    |       |          |       |             | 1      | 5 1/2    | 1 1/2 | 8        | 1      | 1        | 2      | .....    |       |               |            |               |                             | 897       |               |                |
| 14 Lancaster.                                                                                                                                                                                            | Lancaster.      | Conservatory of Arts. | 30.95        | 39.10    | 33.43    | 56.00    | 15.50    | 34.16 | 3             | 15.     | 30.07 |               | 29.34    | 29.27    | 29.30    | 29.66    | 28.38    | 29.30 |               | 8 1/2  | 22      |               | 5      | 6     | 3              |                  | 3.648           | 2 1/2  |          | 3 1/2  |          | 3 1/2 |          |       |             | 1      | 3 1/2    | 3 1/2 | 7        | 3 1/2  | 1        | 1      | 2        | 30.24 | 3             | .....      | 36.48         | 3                           | 927       |               |                |
| 15 York.                                                                                                                                                                                                 | York.           | Calvin Mason.         | 32.90        | 39.07    | 31.00    | 54.00    | 14.00    | 34.32 |               | 12.     | 28.95 |               | 29.46    | 29.45    | 29.47    | 29.80    | 28.50    | 29.46 |               |        |         |               |        |       |                |                  |                 | 2 1/2  |          | 10 1/2 |          |       |          |       |             |        |          | 1 1/2 |          | 18 1/2 |          | .....  |          |       |               |            |               | 924                         |           |               |                |
| 16 Lebanon.                                                                                                                                                                                              |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 17 Dauphin.                                                                                                                                                                                              |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 18 Northumberland.                                                                                                                                                                                       | Northumberland. | Andrew C. Huston.     | 27.44        | 36.66    | 30.27    | 50.00    | 12.50    | 31.49 |               | 7.      | 20.10 |               | 29.25    | 29.36    | 29.29    | 29.61    | 28.28    | 29.27 |               |        |         |               | 4      | 9     | 2              |                  | 3.177           | 7      |          | 5      |          | 2 1/2 |          | 1 1/2 | 3           |        |          | 6 1/2 | 1 1/2    | 1 1/2  | 2        | .....  |          |       |               | 42.45      |               | 896                         |           |               |                |
| 19 Columbia.                                                                                                                                                                                             |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 20 Bradford.                                                                                                                                                                                             |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 21 Tioga.                                                                                                                                                                                                |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 22 Lycoming.                                                                                                                                                                                             |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 23 Union.                                                                                                                                                                                                |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 24 Mifflin.                                                                                                                                                                                              |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 25 Juniata.                                                                                                                                                                                              | Mifflintown.    | J. A. Rinkard.        | 27.29        | 38.13    | 30.04    | 55.00    | 10.00    | 31.82 | 3             | .....   | ..... |               | 29.35    | 29.33    | 29.35    | 29.64    | 28.39    | 29.34 | 3             | 5 1/2  | 20 1/2  | 5             |        |       |                |                  | 5.373           |        |          | 2 1/2  |          | 1     |          | 1 1/2 |             |        | 1        | 1     | 11 1/2   | 12 1/2 | 3        | .....  |          |       |               |            |               | 895                         |           |               |                |
| 26 Perry.                                                                                                                                                                                                |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 27 Cumberland.                                                                                                                                                                                           | Carlisle.       | Prof. W. H. Allen.    | 28.10        | 35.79    | 30.07    | 59.00    | 8.00     | 31.32 | 1 1/2         | 4.      | 25.90 | 2             | 29.23    | 29.21    | 29.22    | 29.54    | 28.45    | 29.32 | 1 1/2         | 4 1/2  | 24 1/2  | 1 1/2         | 2      | 5     | 2              |                  | 5.199           | 2 1/2  |          | 3 1/2  |          | 1     |          | 1 1/2 |             | 1      | 1 1/2    | 3 1/2 | 8        | 3      | 6 1/2    | 2 1/2  | .....    |       |               |            |               |                             | 909       |               |                |
| 28 Adams.                                                                                                                                                                                                | Gettysburg.     | Prof. M. Jacobs.      | 28.61        | 36.69    | 31.11    | 51.25    | 8.00     | 32.14 |               | 8.      | 26.33 |               | 29.25    | 29.23    | 29.25    | 29.52    | 28.00    | 29.24 |               | 9      | 22      |               |        |       |                |                  |                 | 2 1/2  | 2        |        | 4        |       | 3        |       |             |        | 1 1/2    | 1 1/2 | 4        | 2      | 7        | 2 1/2  | 4        | 26.44 | 3             | .....      | 33.97         | 3                           | 932       |               |                |
| 29 Franklin.                                                                                                                                                                                             |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 30 Huntingdon.                                                                                                                                                                                           |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 31 Centre.                                                                                                                                                                                               | Belleville.     | John Harris.          | 24.76        | 31.03    | 26.85    | 40.00    | 6.00     | 27.55 | 2 1/2         | 5.      | 19.96 | 7             | 29.11    | 29.13    | 29.12    | 29.50    | 28.25    | 29.12 | 2 1/2         | 3 1/2  | 24 1/2  | 2 1/2         |        |       |                |                  | 4.046           | 1 1/2  |          | 9      |          |       | 1        | 3     | 3           | 1 1/2  | 2        | 3     | 11       | 3      | 2 1/2    | .....  |          |       |               |            |               | 901                         |           |               |                |
| 32 Potter.                                                                                                                                                                                               |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 33 M'Kean.                                                                                                                                                                                               | Smithport.      | Richard Chadwick.     | 22.61        | 33.10    | 24.42    | 50.00    | 1.00     | 26.71 |               | .....   | ..... |               | 27.94    | 27.98    | 27.99    | 28.25    | 27.30    | 27.97 |               | 4 1/2  | 26 1/2  |               | 1      | 14    |                |                  | 7.296           | 1      |          | 3      |          | 8 1/2 |          | 2 1/2 |             |        | 2        | 11    | 3        | 2 1/2  | .....    |        |          |       |               |            | 944           |                             |           |               |                |
| 34 Clearfield.                                                                                                                                                                                           |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 35 Clearfield.                                                                                                                                                                                           | Ebensburg.      | Richard Lewis.        | 23.61        | 29.26    | 24.84    | 48.00    | 7.00     | 25.90 |               | .....   | ..... |               | 27.62    | 27.59    | 27.61    | 27.90    | 26.85    | 27.61 |               | 3      | 27      | 1             | 1      | 13    |                |                  |                 | 3      |          | 1 1/2  |          | 2 1/2 |          | 4     | 1           | 1      | 3        | 3     | 9        | 2 1/2  | 6 1/2    | 1      | .....    |       |               |            |               |                             | 898       |               |                |
| 36 Bedford.                                                                                                                                                                                              |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 37 Somerset.                                                                                                                                                                                             | Somerset.       | George Mawry.         | 23.90        | 26.73    | 25.13    | 31.00    |          | 8.00  | 25.26         | 15 1/2  | ..... |               | 27.76    | 27.74    | 27.79    | 28.07    | 27.10    | 27.76 | 15 1/2        |        |         |               |        |       |                |                  |                 | 3      |          |        | 1 1/2    |       | 2        |       |             |        |          | 1 1/2 | 2        | 1 1/2  | 6 1/2    | 1      | 15       | ..... |               |            |               |                             |           | 917           |                |
| 38 Indiana.                                                                                                                                                                                              | Indiana.        | Richard White.        | 30.68        | 34.74    | 36.68    | 50.00    | 16.00    | 33.97 |               | 8.      | 24.24 |               | 28.43    | 28.43    | 28.44    | 28.70    | 27.70    | 28.43 |               | 5      | 25 1/2  |               | 5      | 16    |                |                  |                 | 4.132  | 3        |        | 1 1/2    |       | 5        |       |             |        | 1 1/2    | 3     | 6        | 3      | 10 1/2   | .....  |          |       |               |            |               | 929                         |           |               |                |
| 39 Jefferson.                                                                                                                                                                                            | Rose Cottage.   | C. C. Gaskell.        | 33.19        | 28.67    | 23.37    | 46.00    | 10.00    | 25.14 | 3             | .....   | ..... |               | 28.75    | 28.73    | 28.73    | 29.08    | 28.00    | 28.74 | 3             | 4      | 26 1/2  |               |        |       |                |                  |                 | 3.235  | 4        |        |          |       |          |       |             |        |          | 4 1/2 | 4        | 3      | 14 1/2   | 1      | 40.07    | 17    | .....         | 37.14      | 17            | 930                         |           |               |                |
| 40 Warren.                                                                                                                                                                                               |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 41 Venango.                                                                                                                                                                                              |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 42 Armstrong.                                                                                                                                                                                            |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 43 Westmoreland.                                                                                                                                                                                         |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 44 Fayette.                                                                                                                                                                                              | Uniontown.      | Rev. J. P. Withers.   | 29.17        | 33.07    | 29.90    | 50.00    | 0.00     | 30.71 |               | 0.      | 27.00 |               | 28.85    | 28.82    | 28.85    | 29.21    | 28.20    | 28.84 |               | 4 1/2  | 16 1/2  |               | 4      | 15    | 1              |                  | 9.300           |        | 1        | 3 1/2  |          |       |          | 1 1/2 |             |        | 6        |       | 7        |        | 11       | 1 1/2  | .....    |       |               |            | 23.71         |                             | 912       |               |                |
| 45 Green.                                                                                                                                                                                                |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 46 Washington.                                                                                                                                                                                           |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 47 Allegheny.                                                                                                                                                                                            |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 48 Beaver.                                                                                                                                                                                               |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 49 Butler.                                                                                                                                                                                               |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 50 Butler.                                                                                                                                                                                               |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 51 Mercer.                                                                                                                                                                                               | Butler.         | Jacob Mechling.       | 26.52        | 32.87    | 28.00    | 48.00    | 8.00     | 29.13 |               | .....   | ..... |               |          |          |          |          |          |       |               |        |         |               |        | 1     | 12             |                  |                 | 6.354  | 3        |        | 3        |       | 9 1/2    |       |             |        | 13 1/2   |       | 4        |        | 1 1/2    |        | 1        | ..... |               |            |               |                             | 907       |               |                |
| 52 Crawford.                                                                                                                                                                                             |                 |                       |              |          |          |          |          |       |               |         |       |               |          |          |          |          |          |       |               |        |         |               |        |       |                |                  |                 |        |          |        |          |       |          |       |             |        |          |       |          |        |          |        |          |       |               |            |               |                             |           |               |                |
| 53 Erie.                                                                                                                                                                                                 | Erie.           | Park & Reid.          | 30.47        | 34.77    | 31.97    | 50.00    | 19.00    | 32.40 |               | 19.     | 27.15 | 1             | 29.22    | 29.20    | 29.21    | 29.59    | 28.63    | 29.21 |               | 1      | 29 1/2  |               |        |       |                |                  |                 |        | 11       | 1      | 3 1/2    | 1     | 4        | 4     | 3 1/2       | 2      | 1 1/2    | 4     | 4        | 7 1/2  | 3        | 3      | 1        | 1     | .....         |            |               |                             |           |               | 923            |





# INDEX.

AMERICAN PATENTS, LIST OF, WITH EDITOR'S REMARKS, &c.

January, 1839.

|                                                  | PAGE                                         |
|--------------------------------------------------|----------------------------------------------|
| 1. Evaporating fluids, . . . . .                 | William Henry, . . . . . 50                  |
| 2. Bedsteads, . . . . .                          | Thomas Early, . . . . . ib.                  |
| 3. Submarine excavator, . . . . .                | W. P. Brayton and J. Hamilton, . . . . . ib. |
| 4. Curriers' knives, sharpening, . . . . .       | Warren Eggleston, . . . . . 51               |
| 5. Mill Spindles, . . . . .                      | David D. Wagner, . . . . . ib.               |
| 6. Cigars, manufacture of, . . . . .             | William D. Groff, . . . . . ib.              |
| 7. Life and anchor boat, . . . . .               | Joseph Francis, . . . . . 52                 |
| 8. Glass socket lamp, . . . . .                  | H. Whitney and T. Leighton, . . . . . ib.    |
| 9. Excavating machine, . . . . .                 | G. W. Cherry, . . . . . ib.                  |
| 10. Propelling canal boats, . . . . .            | Thomas Jackson, . . . . . ib.                |
| 11. Life boats, . . . . .                        | George Young, . . . . . 53                   |
| 12. Churn, . . . . .                             | Milo B. Hough, . . . . . ib.                 |
| 13. Clips for the shafts of carriages, . . . . . | John Cooper, . . . . . ib.                   |
| 14. Saw mills, . . . . .                         | Eden Baldwin, . . . . . ib.                  |

February, 1839.

|                                                        |                                                     |
|--------------------------------------------------------|-----------------------------------------------------|
| 1. Loom for weaving fringe, &c. . . . .                | Eliza A. D. Judkins, . . . . . 107                  |
| 2. Cast iron wheels for cars, &c. . . . .              | William W. Pennel, . . . . . ib.                    |
| 3. Making oakum, . . . . .                             | James Tibbals, . . . . . ib.                        |
| 4. Bedsteads, chairs, sofas, &c. . . . .               | Edmund Cherrington, . . . . . ib.                   |
| 5. Tanning, . . . . .                                  | William Brown, . . . . . 108                        |
| 6. Temples for looms, . . . . .                        | J. Dennis, Jr. assignee for K. Gibbs, . . . . . ib. |
| 7. Paint Mill, . . . . .                               | Joseph W. Webb, . . . . . ib.                       |
| 8. Camphine oil, . . . . .                             | Augustus V. X. Webb, . . . . . ib.                  |
| 9. Lamp for burning Camphine, . . . . .                | . . . . . 109                                       |
| 10. Fire arms, . . . . .                               | L. Bailey, J. B. Ripley, W. B. Smith, . . . . . ib. |
| 11. Light for light houses, . . . . .                  | Benjamin F. Williams, . . . . . 110                 |
| 12. Pressing hay, cotton, &c. . . . .                  | Joseph C. Baldwin, . . . . . ib.                    |
| 13. Protecting walls and ceilings from fire, . . . . . | Peter Naylor, . . . . . ib.                         |
| 14. Corn skeller, . . . . .                            | Alonza R. Dinsmore, . . . . . ib.                   |
| 15. Crane excavator, . . . . .                         | William S. Otis, . . . . . ib.                      |
| 16. Preparing Caoutchouc, &c. . . . .                  | C. Goodyear, assignee of N. Hayward, . . . . . 111  |
| 17. Steam apparatus, . . . . .                         | Abraham Patterson, . . . . . ib.                    |
| 18. Tailors' shears, . . . . .                         | Rochus Heinisch. . . . . ib.                        |

March, 1839.

|                                              |                                                     |
|----------------------------------------------|-----------------------------------------------------|
| 1. Drying flour, . . . . .                   | J. Balantine and A. Clark, . . . . . 184            |
| 2. Hat bodies, manufacturing, . . . . .      | Hezekiah S. Miller, . . . . . ib.                   |
| 3. Preparing brick mortar, . . . . .         | Oran W. Seeley, . . . . . ib.                       |
| 4. Lightning rods, . . . . .                 | Joseph S. Barber, . . . . . 185                     |
| 5. Planting corn, &c. . . . .                | David S. Rockwell, . . . . . ib.                    |
| 6. Preparing brick mortar, . . . . .         | Ansel Teal, . . . . . ib.                           |
| 7. Cutting shingles, . . . . .               | Ludlam M. Parsons, . . . . . 186                    |
| 8. Rotary steam engine, . . . . .            | Roger M. Sherman, . . . . . ib.                     |
| 9. Cutting potatoes, &c. . . . .             | Abel Williams, . . . . . ib.                        |
| 10. Cutting straw, . . . . .                 | Charles T. Botts, . . . . . 187                     |
| 11. Cutting straw, . . . . .                 | Thomas Hopper, . . . . . ib.                        |
| 12. Thrashing and cleansing grain, . . . . . | Matthew M. McKeever, . . . . . ib.                  |
| 13. Chair for rail roads, . . . . .          | Moncure Robinson, . . . . . ib.                     |
| 14. Many chambered fire arms, . . . . .      | Ebon B. Butterfield, . . . . . 188                  |
| 15. Ascending inclined planes, . . . . .     | W. F. Ketchum, . . . . . ib.                        |
| 16. Locomotive Engines, . . . . .            | D. H. Dotterer and T. Jackson, . . . . . ib.        |
| 17. Cutting shingles, . . . . .              | J. Hinman, J. Thatcher and A. Palmer, . . . . . ib. |
| 18. Smut machine, . . . . .                  | William C. Grines, . . . . . 189                    |
| 19. Thrashing and hulling machine, . . . . . | Thomas Elliot, . . . . . ib.                        |
| 20. Shelling Corn, . . . . .                 | W. McElroy, Jr. and B. and W. Boon, . . . . . ib.   |

|                                                                                  |                                             |     |
|----------------------------------------------------------------------------------|---------------------------------------------|-----|
| 21. Tailors' draughting instrument,                                              | Edward J. Axford,                           | 190 |
| <i>April, 1839.</i>                                                              |                                             |     |
| 1. Church and other bells, and hanging the same,                                 | Ebenezer Dewey,                             | 235 |
| 2. Manufacture of white lead,                                                    | C. Button and H. G. Dyer,                   | 236 |
| 3. Washing machine and clothes press,                                            | Jonathan Read,                              | 237 |
| 4. Garden cultivator,                                                            | John B. Smith,                              | ib. |
| 5. Explosion of steam boilers, preventing injury from,                           | Philip C. Friese,                           | ib. |
| 6. Cutting coats with seams,                                                     | William M. Wiswall,                         | 238 |
| 7. Railway cooking stove,                                                        | Anson Atwood,                               | ib. |
| 8. Corn cultivator,                                                              | John B. Smith,                              | ib. |
| 9. Steam boilers, to prevent explosions in,                                      | Cadwallader Evans,                          | ib. |
| 10. Water Wheels and application of water,                                       | Eliza Martineau, Administratrix, &c.        | 239 |
| 11. Press for hay, cotton, &c.                                                   | Charles W. Hawkes,                          | ib. |
| 12. Grist mill,                                                                  | Oliver Wyman,                               | ib. |
| 13. Propelling canal and other boats,                                            | William Leavenworth,                        | 240 |
| 14. Moulding and casting water wheels,                                           | Stephen Parsons,                            | ib. |
| 15. Hill side Plough,                                                            | John W. Jordan,                             | ib. |
| 16. Bedsteads,                                                                   | C. J. Fountain, J. F. Adams, G. F. Hillyer, | ib. |
| 17. Glasses and frames for spectacles,                                           | Charles L. H. Jackson,                      | 241 |
| 18. Scales for weighing,                                                         | Jonathan Ball,                              | ib. |
| 19. Vice,                                                                        | John Wetherill,                             | ib. |
| 20. Plough,                                                                      | William Small,                              | 242 |
| 21. Fire arms,                                                                   | David Edwards,                              | ib. |
| 22. Horse power,                                                                 | William R. Arnold,                          | ib. |
| 23. Tailors' measure,                                                            | Daniel Williams,                            | ib. |
| 24. Springs for carriages,                                                       | Micah Seabury,                              | ib. |
| 25. Dressing sawed shingles,                                                     | Oliver N. May,                              | ib. |
| <i>May, 1839.</i>                                                                |                                             |     |
| 1. Joints of stone pumps,                                                        | Abraham Von Voorhes,                        | 395 |
| 2. Auger for boring the earth,                                                   | George Page,                                | ib. |
| 3. Fire arms,                                                                    | Nathan Starr,                               | ib. |
| 4. Cutting staves, slats, &c.                                                    | Hardin Branch,                              | 396 |
| 5. Raising canal boats for repairs,                                              | N. N. Penrose and S. F. Palmer,             | ib. |
| 6. Steam boiler furnaces,                                                        | Lucian Maillard                             | ib. |
| 7. Rail road cars,                                                               | Lewis J. Germain,                           | 397 |
| 8. Jack screw,                                                                   | Stephen Vail,                               | ib. |
| 9. Earthen pipes for conveying water,                                            | Charles Stearns,                            | 398 |
| 10. Applying heated air to furnaces, economizing fuel and consuming smoke,       | Frederick P. Dimpfel,                       | ib. |
| 11. Blacksmiths' Tuyere iron,                                                    | John Shugart,                               | 399 |
| 12. Fire engine,                                                                 | John Williams, Jr.,                         | ib. |
| 13. Drilling rock,                                                               | Isaac H. Singer,                            | ib. |
| 14. Construction of presses,                                                     | John J. Wise,                               | 400 |
| 15. Thrashing machine,                                                           | Jeremiah Wrighton,                          | ib. |
| 16. Horizontal spiral bucket water wheel,                                        | Lorenzo Dow Adkins,                         | ib. |
| 17. Balance locks for canals,                                                    | Josiah White,                               | 401 |
| 18. Ships galleys for distilling salt water,                                     | Enoch Hutchinson,                           | ib. |
| 19. Cooking stove,                                                               | Darius Buck,                                | ib. |
| 20. Roller gin for cotton,                                                       | William Whittemore, Jr.,                    | 402 |
| 21. Cooking stoves,                                                              | Micah Ketchum,                              | ib. |
| 22. Tanning,                                                                     | William Herepath,                           | ib. |
| 23. Straps for pantaloons,                                                       | W. H. Simpson,                              | 403 |
| 24. Crimping boot legs,                                                          | John Goodwin, Jr.,                          | ib. |
| Accidents by fire on board of steamboats, prevention of,                         | J. A. Beard,                                | 172 |
| Air, heated, reply to Dr. Hare's remarks on Dr. Gries' essay on warming rooms by |                                             | 1   |
| Air, effect of rarefaction of, on moisture                                       |                                             | 419 |
| Algiers, hydraulic works at, by M. Poirel                                        |                                             | 177 |
| Alkali, decomposing muriate of soda for manufacturing mineral, <i>patent.</i>    |                                             | 118 |
| Alloying metals by cementation, <i>patent</i>                                    |                                             | 120 |
| American geologists, association of                                              |                                             | 218 |



|                                                                        |            |
|------------------------------------------------------------------------|------------|
| American Repertory, notice of                                          | 143        |
| Ammonia, manufacture of liquid for dyeing, &c. <i>patent</i>           | 191        |
| Ammoniacal salts, action of on glass                                   | 330        |
| Analysis of lime stones                                                | 158        |
| Angle of splay for the wing walls of culverts, &c. by E. Morris, C. E. | 290        |
| Animal power, Smeaton's estimate of                                    | 142        |
| Annals, Poggendorf's, for 1840, notice of, by Prof. J. C. Booth        | 391        |
| Anthracite coal, application of, to blast-furnaces, &c.                | 136        |
| iron                                                                   | 267        |
| Antifriction machinery, advantages of                                  | 265        |
| Antimony, mode of making oxides of lead and                            | 126        |
| on the oxide of                                                        | 326        |
| Arago, M. history of the steam engine                                  | 3, 73, 145 |
| Arches, expansion of                                                   | 349        |
| Area of excavation and embankment, query relative to                   | 35         |
| reply to query                                                         | 97         |
| Argand lamps, on obtaining increased light from                        | 357        |
| Arsenic from antimony, method of distinguishing in case of poisoning   | 260        |
| presence of, in tin                                                    | 329        |
| Artesian springs in Mid-Lothian, &c. experiments on                    | 274        |
| wells                                                                  | 270        |
| Arts and Artisans at home (England) and abroad.                        |            |
| Wages at home                                                          | 306        |
| in Belgium, and physical condition of the artisans                     | 313        |
| France                   do                   do                   do  | 361        |
| in Switzerland       do                   do                   do      | 371        |
| Arts, connexion of geology with the                                    | 128        |
| of Berlin, institute of                                                | 41         |
| Assay of gold                                                          | 262, 379   |
| Asphalte pavement, &c. report on                                       | 409        |
| Astronomy, notice of introduction to                                   | 100        |
| Atmosphere, whether plants acquire azote from the                      | 282        |
| Auroral arch of May 29th, 1840, by A. Holcomb,                         | 390        |
| Austria, railroads in                                                  | 272        |
| Azote from the atmosphere, whether plants acquire                      | 282        |
| Bache, Pres. A. D. notice of report on education in Europe, by         | 37         |
| Bath, economical portable hot                                          | 130        |
| Beard, J. A. on prevention of accidents by fire on board steamboats    | 172        |
| description of improvement on Towne's bridge                           | 175        |
| Beet-sugar, process for making                                         | 374        |
| Belgium, wages and physical condition of artisans in                   | 313        |
| Berlin, Institute of arts of                                           | 41         |
| Bevel wheels, machine for cutting the teeth of                         | 202        |
| <i>Bibliographical Notices.</i>                                        |            |
| Report on education in Europe, by Pres. A. D. Bache                    | 37         |
| Taylor's scientific memoirs,                                           | 47         |
| Introduction to astronomy, by Prof. D. Olmsted                         | 101        |
| Black and Caspian seas, leveling between the                           | 67         |
| rock tunnel, description of, by W. H. Wilson, C. E.                    | 87         |
| Blast furnaces, &c. application of anthracite coal to                  | 136        |
| Blue and other colours, dyeing, <i>patent</i>                          | 195        |
| Boilers of locomotive engines, on tubing the                           | 141        |
| Booth, Prof. J. C. notice of Poggendorf's annals for 1840              | 391        |
| Boring granite rocks                                                   | 141        |
| Brick machine                                                          | 353        |
| and tile machine, marquiss of Tweeddale's                              | 140        |
| Bridge, description of improvement on Towne's                          | 175        |
| Bridges, on the angle of splay for the wing walls of culverts, &c.     | 290        |
| Bude light                                                             | 210        |
| Calamine and iron pyrites                                              | 358        |
| Canals, &c. on mensuration of excavation, &c. upon                     | 21         |
| Candles, preparing tallow for the manufacture of, <i>patent</i>        | 305        |

|                                                                                    |          |
|------------------------------------------------------------------------------------|----------|
| Caoutchouc, Ure on the manufacture of                                              | 250      |
| ———— preparing, for manufacturing, <i>patent</i>                                   | 115      |
| Carbon, in cast iron and steel, process for determining the                        | 327      |
| ———— new variety of                                                                | 201      |
| Carbonization of Vegetables,                                                       | 328      |
| Carriages, improvement in railway                                                  | 215      |
| Case hardening                                                                     | 205      |
| Caspian sea, leveling between the Black and                                        | 67       |
| Cast iron, strength, &c. of, obtained from the hot and cold blast, by W. Fairbairn | 54       |
| ———— &c. relative combinations of the constituents of                              | 137      |
| Cast steel, manufacturing of, <i>patent</i>                                        | 246      |
| Castor oil, soap from, <i>patent</i>                                               | 118      |
| Ceilings, protecting plastered walls, &c. from effects of fire, <i>patent</i>      | 112      |
| Cementation, alloy of metals by, <i>patent</i>                                     | 120      |
| Charcoal, and peat                                                                 | 203      |
| ———— combustion of, in close rooms, &c.                                            | 217      |
| Chemistry, notice of manual of                                                     | 143      |
| Chlorate of potash, manufacture of                                                 | 357      |
| Chrome, new chloride of                                                            | 329      |
| Clinometer, the                                                                    | 407      |
| Clough, floating, for clearing channels                                            | 70       |
| Coal, anthracite, application of, to blast furnaces, &c.                           | 136      |
| ———— fields, origin of vegetation of                                               | 205      |
| Coast of the United States, Hassler's report on survey of the                      | 91       |
| Cockerills of Liege, notice of the Messieurs                                       | 263      |
| Coining press at the U. States Mint, report on                                     | 298      |
| Columbia railroad, notes on the Philadelphia and                                   | 331      |
| Comets, Galle's three                                                              | 358      |
| Copal varnish,                                                                     | 378      |
| Copperplates engraved in relief by voltaic electricity                             | 62       |
| Crystallization of Carburets                                                       | 134      |
| Culverts, &c. Morris on the angle of splay for the wing walls of                   | 290      |
| Daguerreotype, a curious application of the                                        | 285      |
| Daguerre's photogenic process, one great obstacle to                               | 142      |
| Deflagration, electric                                                             | 205      |
| Dextrine, improvement in the manufacture of, <i>patent</i>                         | 116      |
| Divisibility of matter                                                             | 133      |
| Dry-rot, hardening and preserving wood from the, <i>patent</i>                     | 248      |
| Dyeing blue and other colours, <i>patent</i>                                       | 195      |
| ———— &c. manufacture of liquid ammonia for, <i>patent</i>                          | 191      |
| Earthy strata, instrument for ascertaining the depth of soft mineral or            | 407      |
| Eastwick & Harrison's locomotive, performance of                                   | 99       |
| Education in Europe, notice of Pres. A. D. Bache's report on                       | 37       |
| Edwardsite and monazite, identity of                                               | 289      |
| Eggs, eccaleqbion, or machine for hatching                                         | 286      |
| Electric condition of iron, an anomalous                                           | 208      |
| ———— deflagration                                                                  | 205      |
| ———— tension, a remarkable property of                                             | 204      |
| Electrical telegraph, Great Western railway                                        | 352      |
| Electricity, engravings in relief by voltaic                                       | 62       |
| ———— producing copies of medals by voltaic                                         | 255      |
| Electro-magnetic telegraph of the Great Western rail-way                           | 271      |
| ———— magnetism as a moving power                                                   | 199      |
| Elkinton's mode of gilding by immersion                                            | 285      |
| Ellett, jr. C., on the tariff of tolls on the public improvements of the U. States | 167, 225 |
| England, wages of the artisans in                                                  | 306      |
| ———— exports and imports of metals in                                              | 349      |
| Engravings in relief by voltaic electricity                                        | 62       |
| Espy & Redfield's meteorological theories examined                                 | 162      |
| Ether, action of on indigo                                                         | 263      |
| Excavation and embankment, query relative to the area of                           | 35       |
| ———— reply to query                                                                | 97       |

|                                                                                  |          |
|----------------------------------------------------------------------------------|----------|
| Excavation and embankment calculations, prismoidal formula used in               | 381      |
| — upon canals, &c. mensuration of                                                | 21       |
| Excavator, locomotive                                                            | 68       |
| Explosions, on the cause of steam boiler                                         | 350      |
| Export and import of metals in England                                           | 349      |
| Fabrics of fibrous materials, manufacturing                                      | 243      |
| Fairbairn, W. on strength, &c. of cast iron obtained from the cold and hot blast | 54       |
| Faucet for drawing thick and drying liquids                                      | 379      |
| Felting, manufacture of soap for, <i>patent</i>                                  | 116      |
| Fermentation, on the nature of yeast                                             | 258      |
| Fire, protecting plastered walls, &c. from effects of, <i>patent</i>             | 112      |
| — in steamboats, preventing accidents by                                         | 172      |
| — damp                                                                           | 273      |
| Flame, protecting wood from, <i>patent</i>                                       | 196      |
| Fluency, or viscosity of liquids at different temperatures                       | 131      |
| Fluorine, on the insulation of                                                   | 355      |
| — with selenium, note on a compound of                                           | 356      |
| France, wages and the physical condition of the artisans in                      | 361      |
| Friction, researches on the disengagement of heat by                             | 317      |
| — anti, machinery, advantages of                                                 | 265      |
| Furnace, method of using a common furnace as a muffle                            | 66       |
| Furnaces, forges, &c. anthracite applied to                                      | 136      |
| <i>Franklin Institute.</i>                                                       |          |
| Annual meeting, minutes of                                                       | 101      |
| Sixteenth annual report of Board of Managers                                     | 102      |
| Board of Managers, minutes of, and appointment of Standing Committees            | 105      |
| Sixty-fifth quarterly report of Board of Managers                                | 296      |
| Conversation Meeting, notice of                                                  | 300, 392 |
| <i>Committee on Science and the Arts.</i>                                        |          |
| Report on E. Clark's process for making white lead                               | 232      |
| — J. P. Bakewell's self-acting safety valve                                      | 233      |
| — Dr. J. Rhoads' maps and globes for the use of the blind                        | 297      |
| — Coining press at the United States mint                                        | 298      |
| — the substitution of lime for salt in preserving ships                          | 393      |
| Galle's three comets                                                             | 358      |
| Galls used in black ink                                                          | 378      |
| Gas, best means of burning, for supplying heat                                   | 198      |
| — lights in London                                                               | 359      |
| — produced by a new process                                                      | 269      |
| — preparing, for illumination, <i>patent</i>                                     | 115      |
| — retorts, improvement in construction of, <i>patent</i>                         | 305      |
| — improved mode of working                                                       | 128      |
| Gases, that issue from the ground, instrument for determining                    | 64       |
| Gates for crossing railways                                                      | 272      |
| Geologists, association of American                                              | 219      |
| Geology, microscopic                                                             | 209      |
| — of the moon                                                                    | 283      |
| — connexion of, with the arts                                                    | 128      |
| Gilding by immersion, Elkinton's mode of                                         | 285      |
| Glass, action of ammoniacal salts on                                             | 330      |
| Globes for the use of the blind, report on Dr. Rhoads'                           | 297      |
| Gold, assay of                                                                   | 262, 379 |
| Gowen & Marx, performance of locomotive engine                                   | 99       |
| Granite rocks, boring                                                            | 141      |
| Greenwich and New York, difference of longitude between                          | 213      |
| Gries, Dr. reply to Dr. Hare's remarks on essay on warming rooms by heated air,  | 1        |
| Hamilton, Prof. J. meteorological observations at Nashville                      | 48, 223  |
| Hassler's report of coast survey                                                 | 91       |
| Heat, best means of burning gas for supplying                                    | 198      |
| — by friction, researches on the disengagement of                                | 317      |
| — emission of, from rough and polished surfaces                                  | 321      |
| Height of trees, &c. instrument for measuring                                    | 413      |



|                                                                   |                             |
|-------------------------------------------------------------------|-----------------------------|
| Hinges, Edwards' improved                                         | 126                         |
| Holcomb, A. observations on auroral arch of May 29th, 1840        | 390                         |
| Holes in sheets of melting ice, cause of                          | 278                         |
| Hot and cold blast, strength, &c. of cast iron obtained from the  | 54                          |
| — bath, economical portable                                       | 130                         |
| Hungary, soda manufactory in                                      | 378                         |
| Hydraulic works at Algiers, by M. Poirel                          | 177                         |
| Hydrographic paper                                                | 330                         |
| Ice, cause of holes in sheets of melting                          | 278                         |
| Illumination, purifying gas for, <i>patent</i>                    | 115                         |
| Immersion, Elkinton's mode of gilding by                          | 285                         |
| Imports of metals in England, exports and                         | 349                         |
| Inclined planes, enabling locomotives to ascend, <i>patent</i>    | 190                         |
| Indian rubber, preparing for manufacturing, <i>patent</i>         | 115                         |
| Indigo, action of ether on                                        | 263                         |
| Ink, manufacture of black                                         | 378                         |
| Iron, an anomalous electric condition of                          | 208                         |
| — analysis of, acted on by sea water                              | 409                         |
| — anthracite                                                      | 267                         |
| — improvement in manufacturing, <i>patent</i>                     | 301                         |
| — obtained from hot and cold blast, strength of cast              | 54                          |
| — relative combinations of the constituents of cast and malleable | 137                         |
| — preserving at a minimum of oxidation the sulphate of            | 329                         |
| — trade, statistics of the                                        | 211                         |
| — pyrites, and calamine                                           | 358                         |
| — and lead, destructive combination of                            | 125                         |
| — steel, improvement in manufacture of                            | 123                         |
| — process for determining the carbon in cast                      | 327                         |
| — hardening, and preserving wood from dry-rot, <i>patent</i>      | 248                         |
| Italian scientific association, meeting at Pisa                   | 285                         |
| Kyanizing wood, effects of                                        | 203                         |
| Lamp, polyphotal                                                  | 416                         |
| — argand, increased light from                                    | 357                         |
| Lead and antimony, mode of making oxides of                       | 126                         |
| — destructive combination of iron and                             | 125                         |
| — white, manufacture of, <i>patent</i>                            | 193                         |
| — theory of the formation of                                      | 196                         |
| Leveling between the Black and Caspian seas                       | 67                          |
| Light, the Bude                                                   | 210                         |
| — mode of obtaining in argand lamps, an increase of               | 357                         |
| — new source of                                                   | 407                         |
| Lightning, magnetic effect of                                     | 143                         |
| Lime from magnesia, separation of                                 | 262                         |
| — stones, Rogers & Boyè's analysis of                             | 158                         |
| — substitution of, for salt, in preserving ships                  | 293                         |
| Linen, woolen, &c. manufacturing fabrics from, <i>patent</i>      | 243                         |
| Liquids, apparatus for measuring the relative refraction of       | 67                          |
| — faucet for drawing thick and drying                             | 379                         |
| — fluency or viscosity of, at different temperatures              | 131                         |
| Lock gates, framing without iron-work                             | 71                          |
| Locomotive excavator                                              | 68                          |
| — engine, 'Gowan & Marx,' performance of                          | 99                          |
| — engines, enabling, to ascend inclined planes, <i>patent</i>     | 190                         |
| — on tubing the boilers of                                        | 141                         |
| Locomotives on common roads, report on                            | 268                         |
| London, gas lights in                                             | 359                         |
| Longitude, difference of, between Greenwich and New York          | 213                         |
| Lunar occultations                                                | 71, 144, 216, 288, 360, 420 |
| Machinery, advantages of antifriction                             | 265                         |
| Magnesia, separation of lime from                                 | 262                         |

|                                                                               |                             |
|-------------------------------------------------------------------------------|-----------------------------|
| Magnetic effects of lightning                                                 | 143                         |
| ----- electro-telegraph of the Great Western railway                          | 271, 352                    |
| Magnetism, electro, as a motive power                                         | 199                         |
| Malleable and cast iron, relative combinations of the constituents of         | 137                         |
| Manual of chemistry, notice of                                                | 143                         |
| Maps and globes for the blind, report on Dr. Rhoads'                          | 297                         |
| Masonry calculations, prismoidal formula used in                              | 381                         |
| Matter, divisibility of                                                       | 133                         |
| Measures, Hassler's report on weights and                                     | 91                          |
| Medals, producing by voltaic electricity copies of                            | 255                         |
| Memoirs, scientific, by R. Taylor, F. S. A.                                   | 47                          |
| Metals, alloying by cementation, <i>patent</i>                                | 120                         |
| ----- deposit of moisture on                                                  | 330                         |
| ----- in England, exports and imports of                                      | 349                         |
| Meteorological observations,                                                  | 72, 144, 216, 288, 360, 420 |
| ----- at Nashville, by Prof. J. Hamilton,                                     | 48, 223                     |
| ----- theories of Espy and Redfield, examined                                 | 162                         |
| Meteorology, notice of the advancement of                                     | 20                          |
| Microscopic geology                                                           | 209                         |
| Microscopical investigations                                                  | 287                         |
| Mineral alkali, decomposing muriate of soda for manufacture of, <i>patent</i> | 118                         |
| ----- or earthy strata, instrument for ascertaining the depth of soft         | 407                         |
| Minerals, proposed exchange of                                                | 143, 287                    |
| Mineralogy, advancement of, 1837                                              | 20                          |
| Mint, report on coining press at the United States                            | 298                         |
| Monazite, identity of Edwardsite and                                          | 289                         |
| Moon, geology of the                                                          | 283                         |
| Morris, E. on mensuration of excavation, &c. on canals, &c.                   | 21                          |
| ----- on angle of splay for wing walls of culverts and bridges                | 290                         |
| ----- on prismoidal formula used in excavation, &c. calculations              | 381                         |
| Motive power, electro-magnetism as a                                          | 199                         |
| Mould board for a plough, <i>patent</i>                                       | 113                         |
| Muffle furnace, method of using a common furnace as a                         | 66                          |
| Murchison's silurian system, notice of                                        | 353                         |
| Musical instruments, platina wire for                                         | 359                         |
| Natchez, observations by Dr. H. Tooley on the tornado at                      | 387                         |
| New York, difference of longitude between Greenwich and                       | 213                         |
| Notices.                                                                      |                             |
| Proposed exchange of minerals                                                 | 143, 287                    |
| Manual of chemistry                                                           | 143                         |
| American Repertory                                                            | ib.                         |
| Oil, castor, soap from                                                        | 118                         |
| Olmsted's introduction to astronomy                                           | 100                         |
| Optical machine exhibited by R. Roberts                                       | 221                         |
| Oxidation, preserving sulphate of iron at a minimum of                        | 329                         |
| Oxide of antimony                                                             | 326                         |
| Oxides of lead and antimony, mode of making                                   | 126                         |
| Palladium, on the use of the metal                                            | 201                         |
| Paper hangings, manufacture of                                                | 127                         |
| ----- hydrographic                                                            | 330                         |
| Patents, American, list, with remarks                                         | 50, 107, 184, 235, 395      |
| ----- specifications of                                                       | 112, 190                    |
| ----- English,                                                                | 115, 191, 243, 301          |
| Peat and charcoal                                                             | 203                         |
| Philadelphia and Columbia railroad, notes on the                              | 331                         |
| Pisa, meeting of the Italian scientific association at                        | 285                         |
| Piston, efficacy or gross power of steam exerted on the                       | 351                         |
| Platina sponge, new re-actions determined by                                  | 135, 325                    |
| ----- wires for musical instruments                                           | 359                         |
| Plants, whether they acquire azote from the atmosphere                        | 282                         |
| Plumbago, apparent production of                                              | 409                         |

|                                                                                   |               |
|-----------------------------------------------------------------------------------|---------------|
| Plough, mould board for a, <i>patent</i>                                          | 113           |
| Poggendorf's Annals for 1840, notice of, by Prof. J. C. Booth                     | 391           |
| Poisoning, to distinguish arsenic from antimony in case of                        | 260           |
| Polyphotal lamp                                                                   | 416           |
| Portable hot bath                                                                 | 130           |
| Potash, manufacture of chlorate of                                                | 357           |
| Potassium and sodium, on the preparation of                                       | 328           |
| Power, Smeaton's estimate of animal                                               | 142           |
| ——— electro-magnetism as a motive                                                 | 199           |
| Premiums, Telford, to be awarded by the institute of civil engineers of London    | 35            |
| Protochloride of tin, anhydrous                                                   | 202           |
| Railroad, notes on the Philadelphia and Columbia                                  | 331           |
| ——— the Zarskejeselo                                                              | 142           |
| Railroads in Austria                                                              | 272           |
| ——— &c. Morris on mensuration of excavations, &c.                                 | 21            |
| Railway, reports                                                                  | 215           |
| ——— bars, sawing machine for cutting off                                          | 70            |
| ——— carriages, improvements in                                                    | 215           |
| ——— electro-magnetic telegraph of the Great Western                               | 271           |
| Railways, gates for crossing                                                      | 272           |
| ——— present mode of executing, &c.                                                | 140           |
| Raisin sugar                                                                      | 376           |
| Rarefaction of air, influence of, on moisture, by Prof. R. Hare                   | 419           |
| Re-actions, new, determined by platina sponge                                     | 135, 325      |
| Redfield & Espy's meteorological theories examined                                | 162           |
| Refraction of liquids, apparatus for measuring the relative                       | 67            |
| Repertory, American, notice of the                                                | 143           |
| Retorts, improvements in construction of gas, <i>patent</i>                       | 305           |
| ——— improved mode of working gas                                                  | 128           |
| Roads, report on locomotives on common                                            | 268           |
| ——— steam conveyances on common                                                   | 347           |
| Roberts, R. optical machine exhibited by                                          | 221           |
| Rocks, boring granite                                                             | 141           |
| Safety valve, report on J. P. Bakewell's self-acting                              | 233           |
| ——— description of do. do.                                                        | 234           |
| Salt, manufacture of                                                              | 262           |
| ——— substitution of lime for, in preserving ships                                 | 393           |
| Salts, ammoniacal, action of, on glass                                            | 330           |
| Sawing machine for cutting off railway bars                                       | 70            |
| Scientific association, meeting at Pisa, of the Italian                           | 285           |
| ——— memoirs, notice of Taylor's                                                   | 47            |
| Silk, formation of                                                                | 67            |
| ——— &c. manufacturing fabrics from, <i>patent</i>                                 | 243           |
| Silurian system, notice of Murchison's                                            | 353           |
| Soap, manufacture of, <i>patent</i>                                               | 244, 245, 305 |
| ——— for felting, &c. manufacture of, <i>patent</i>                                | 116           |
| Soda for manufacturing mineral alkali, decomposition of muriate of, <i>patent</i> | 118           |
| ——— manufactory in Hungary                                                        | 378           |
| Sodium, on the preparation of potassium and                                       | 328           |
| Sounding, or boring at great depths                                               | 418           |
| Spongy platina, new re-actions determined by                                      | 135, 325      |
| Springs, artesian, in Mid-Lothian, &c. experiments on                             | 274           |
| Starch, improvement in the manufacture of, <i>patent</i>                          | 121           |
| ——— sugar                                                                         | 376           |
| Statistics of the iron trade                                                      | 211           |
| Steam, efficacy or gross power of, exerted on the piston                          | 351           |
| Steam boats, preventing of accidents by fire on board of                          | 172           |
| ——— boiler explosions, cause of                                                   | 350           |
| ——— conveyance on common roads                                                    | 347           |
| ——— engine, history of, by M. Arago                                               | 3, 73, 145    |
| ——— with reference to their consumption of steam                                  | 341           |
| ——— novel mode of conveying a                                                     | 359           |



|                                                                                |          |
|--------------------------------------------------------------------------------|----------|
| Steam engines, improvements in, <i>patent</i>                                  | 248      |
| — &c. application of anthracite coal to                                        | 136      |
| Steel, manufacture of cast, <i>patent</i>                                      | 246      |
| — and cast iron, carbon in                                                     | 327      |
| — process for determining the carbon in cast iron and                          | 327      |
| — improvement in manufacture of iron and                                       | 123      |
| — &c. relative combinations of the constituents of                             | 137      |
| Strata, instrument to ascertain the depth of soft mineral or earthy            | 407      |
| Sugar, on beet                                                                 | 374      |
| — raisin                                                                       | 376      |
| Sulphate of iron, preserving at minimum oxidation                              | 329      |
| Surfaces, emission of heat from rough and polished                             | 321      |
| Switzerland, wages and physical condition of the artisans in                   | 371      |
| <i>Specifications of Patents.</i>                                              |          |
| Protecting plastered walls, &c. from the effect of fire— <i>Naylor's</i>       | 112      |
| Mould board for a plough— <i>Witherow's</i>                                    | 113      |
| Preparing caoutchouc for manufacturing— <i>Goodyear's</i>                      | 115      |
| Purifying gas for illumination— <i>Phillip's</i>                               | ib.      |
| Improvements in the manufacture of dextrine— <i>Heuze</i>                      | 116      |
| Manufacture of soap for felting, &c.— <i>Haden's</i>                           | 118      |
| Decomposing muriate of soda for manufacturing mineral alkali— <i>Barrett's</i> | ib.      |
| Alloying metals by cementation— <i>Berry's</i>                                 | 120      |
| Manufacture of starch— <i>Jones'</i>                                           | 121      |
| Enabling locomotives to ascend inclined planes— <i>Ketchum's</i>               | 190      |
| Manufacture of liquid ammonia for dyeing, &c.— <i>Watson's</i>                 | 191      |
| — of white lead— <i>Scwell's</i>                                               | 193      |
| — of materials for dyeing blue, &c.— <i>Watson's</i>                           | 195      |
| Composition for protecting wood from flame— <i>Davies'</i>                     | 196      |
| Manufacturing fabrics from linen, &c.— <i>Nickel's</i>                         | 243      |
| Manufacture of soap— <i>Davis'</i>                                             | 244      |
| — <i>Poote's</i>                                                               | 245      |
| — cast steel— <i>Vicker's</i>                                                  | 246      |
| Preserving wood, &c. from decay— <i>Burnet's</i>                               | 247      |
| — vegetable substances from decay— <i>Hall's</i>                               | 248      |
| Hardening wood and iron, &c.— <i>Pons'</i>                                     | ib.      |
| Improvements in steam engines— <i>Petrie's</i>                                 | 248      |
| Raising, dressing and cropping the pile of woollens, &c.— <i>Walton's</i>      | 249      |
| Manufacture of iron— <i>Gossage's</i>                                          | 301      |
| Impregnating wood, &c. with chemical materials— <i>Uzielle's</i>               | 303      |
| Construction of gas retorts— <i>Higginbotham's</i>                             | 305      |
| Manufacturing soap and preparing tallow for making candles— <i>Hawes'</i>      | ib.      |
| Tallow for manufacture of candles, preparing, <i>patent</i>                    | 305      |
| Telegraph, electro-magnetic, of the Great Western railway                      | 271      |
| — Great Western electrical                                                     | 352      |
| Telford premiums, to be awarded by the Institute of Civil Engineers, London    | 35       |
| Temperature of water at great depths, ascertaining                             | 214      |
| — of artesian springs                                                          | 274      |
| Temperatures, fluency or viscosity of liquids at different                     | 131      |
| Tension, a remarkable property of electric                                     | 204      |
| Tides, new theory of                                                           | 209      |
| Tile machine, Marquis of Tweeddale's brick and                                 | 140      |
| Tin, anhydrous protochloride of                                                | 202      |
| — presence of arsenic in                                                       | 329      |
| Toll, on the tariffs of, on public improvements in the U. States,              | 167, 225 |
| Tornado at Natchez, Miss. observations on, by D. H. Tooley                     | 387      |
| Towne's bridge, description of improvements on                                 | 175      |
| Trade, statistics of the iron                                                  | 211      |
| Trees, &c. instrument for measuring heights of                                 | 413      |
| Tubing the boilers of locomotive engines                                       | 141      |
| Tunnel, description of Black Rock                                              | 87       |
| Turbine, or French and German water wheel                                      | 403      |
| Ure on the caoutchouc manufacture                                              | 250      |

|                                                                          |          |
|--------------------------------------------------------------------------|----------|
| Ure on yeast and fermentation                                            | 258      |
| Valve, safety, Bakewell's self-acting                                    | 234      |
| Varnish, copal                                                           | 378      |
| Vegetable substances, preserving from decay, <i>patent</i>               | 248      |
| Vegetables, on the carbonization of                                      | 328      |
| Vegetation of our coal fields and wealdens, origin of                    | 205      |
| Vermin, rendering wood repulsive of, <i>patent</i>                       | 248      |
| Viscosity or fluency of liquids at different temperatures                | 131      |
| Voltaic electricity, engravings in relief by                             | 62       |
| ————— producing copies of medals by                                      | 255      |
| Wages in England                                                         | 306      |
| ————— Belgium                                                            | 313      |
| ————— France                                                             | 361      |
| ————— Switzerland                                                        | 371      |
| Walls, &c. protecting from the effects of fire, plastered, <i>patent</i> | 112      |
| Water at great depths, ascertaining temperature of                       | 214      |
| ————— wheel, new overshot                                                | 211      |
| Wax, mode of discovering the adulteration of                             | 330      |
| Wealdens, origin of the vegetation of our coal fields and                | 205      |
| Weather, notice of, &c. at Nashville, by Prof. J. Hamilton               | 221      |
| Weights and measures, Hassler's report on standard                       | 91       |
| Wells, artesian                                                          | 270      |
| ————— or springs, artesian, in Mid-Lothian, &c. experiments on           | 274      |
| Wheels, machine for cutting the teeth of bevel                           | 202      |
| White lead, improvement in manufacturing, <i>patent</i>                  | 193      |
| ————— report on E. Clark's process for making                            | 232      |
| ————— theory of the formation of                                         | 196      |
| Wilson, W. H. description of the Black Rock Tunnel                       | 87       |
| ————— notes on Philadelphia and Columbia railroad                        | 331      |
| Wires for musical instruments, platina                                   | 359      |
| Wood, impregnating with chemical materials, <i>patent</i>                | 303      |
| ————— effects of Kyanizing                                               | 203      |
| ————— improvements in preserving from decay, <i>patent</i>               | 247, 248 |
| ————— protecting from flame, <i>patent</i>                               | 196      |
| ————— and iron hardening, and preserving from dry-rot, <i>patent</i>     | 248      |
| Woolen, &c. manufacturing fabrics from, <i>patent</i>                    | 243      |
| ————— raising, dressing, and cropping the pile of, <i>patent</i>         | 249      |
| Water-wheel, the turbine, or French and German                           | 403      |
| Yeast and fermentation, on the nature of                                 | 258      |
| Zarskojeselo railroad                                                    | 142      |

